

# **Elementary Electronic Kits & Interactive Web Database**

A Senior Project

presented to

the Faculty of the Computer Engineering

California Polytechnic State University, San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

by

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March 2010

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# I. ABSTRACT

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The Elementary Electronic Kit and Interactive Web Database (E-Kit) project will focus on bridging the gap between Cal Poly students and local elementary school to raise interests in engineering. Its main purpose is expose local elementary school students to basic engineering concepts through simple interactive engineering experiments and lessons. The initial idea and proposal for this project was introduced by John Oliver, senior project advisor, whose main goal is to provide a service that would allow local elementary school teachers to bring in Cal Poly student volunteers to teach basic engineering lessons to their class. Lessons will focus on specific grade level's math and science objectives while introducing new related engineering ideas.

There are two main design requirements to the overall system: a basic template for each experimental lesson (E-Kits) and a corresponding interactive web database. The first design aspect involves the development of a basic easy-to-follow template for the engineering kits (E-Kits). The template will be used as the basic structure for future Cal Poly students to develop future E-kits that will be taught in elementary school classrooms. The second design aspect requires the development of an interactive website that integrates a database on a web server to store valuable E-kit information. The website will allow Cal Poly student volunteers and local elementary school teachers to use it as a means of setting up lesson reservations and appointments. Student volunteers will be able sign up to administer lessons by providing their availability and selecting which kit they would like to teach. Elementary school teachers will have to ability to browse available kits and lessons, and reserve an appropriate time and date for a Cal Poly student volunteer to come by and teach their class.

Design and testing for this project consists of many trials based on outside feedback from its " end-users." This testing approach allows for the discovery of cases and necessary

requirements that may not have been considered. These discoveries require revisions to be made in order to improve the quality of the final project's end goal usable functionality.

## II. PROPOSAL

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### INTRODUCTION

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In a society where students in the classroom need to constantly be challenged, motivated, and entertained, the need for new innovative interactive education is essential. The Elementary Electronic Kit (E-Kit) project is aimed towards satisfying this need by finding new ways to make learning more engaging and appealing. By providing this new interactive approach to teaching and learning, we have the ability to expose younger students to advanced mathematical and scientific engineering concepts. This approach also provides students with a fun alternative to learning which allows them to explore new ideas beyond the basic elementary school curriculum.

### OBJECTIVE

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The main purpose of the E-Kit project is to provide elementary school students from grades three through six with an opportunity to “learn-by-doing” and explore various engineering concepts through simple interactive experiments. Each of the experiments developed for this project will also focus on and help satisfy a specific set of science and mathematical school standards required for each grade level by the California State Board of Education. The corresponding website will allow elementary school teachers to reserve and set-up sessions with Cal Poly students volunteers to administer engineering lessons to their class. By creating a relationship with Cal Poly students and local elementary schools, we have the opportunity to help the younger community build interests towards engineering in their futures.

## WHAT IS AN E-KIT?

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An E-Kit is a simple engineering experiment that is aimed to interactively teach elementary school students lessons in their grade level's math and science curriculum. Each experiment will also introduce students to basic engineering concepts related to the experimental topics associated to each grade level's learning objectives.

For example, the Simple Electromagnet kit developed for this project focuses on supplementing the magnetism requirement of the fourth grade elementary school science curriculum. The kit also introduces new ideas concerning electromagnetism and how to build a simple electric circuit using a battery, iron nail and copper wire.

### III. Requirements

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The final system for the Elementary Electronic Kit and Interactive Web Database project consists of two main components: a teaching component and program driver. Both are extremely essential for provided the end goals of the outreach program:

- ***Electronic Experimental Kit (E-Kit)***

The teaching component that requires the development of an electronic experimental kit that focuses on a specific set of math and science objectives. This component also requires a corresponding lesson plan and instructional worksheet for the experiment.

- **Interactive Web Database**

The program driver component that requires the development of an interactive user-friendly web database catalog for browsing available E-Kits, as well as provide a check out system for the lessons.

The following sections lists detailed specifications and requirements each of these components must provide to the overall system's service.

#### E-KIT

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The initial project design required the development of at least 3-4 simple experimental kits and lessons. However, the number of kits actually developed was reduced to one experiment to ensure that the final project would have at least one basic template to follow. This experimental kit will be used as the basic template for developing other future kits.

Each experimental kit (E-Kit) should fulfill the following requirements:

1. Lessons and kits must be administered and completed in an hour's class time.

- a. Each lesson must provide a workbook with step-by-step instructions and questions for students to answer and complete during the experiment.
2. Each kit must come with its own lesson plan and instructional guide that is flexible and easy to alter.
  - a. Each lesson plan must satisfy a variety of math and science California Public School Content Standards for grades three through six.
  - b. Each lesson must meet a set of educational objectives, yet be appealing and appropriate for each grade level and student's capability.
3. Each kit is easy to maintain.
  - a. All parts must be easily replaced and be easily accessible.
  - b. Each kit must be securely stored for lesson administrations.

## INTERACTIVE WEB DATABASE & WEB-SERVER

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The main goal of the website is to provide an easy-to-use interactive catalog system of all available E-Kits, provide ability for Cal Poly student volunteers to sign up for lessons to teach, and allow elementary school teacher to “checkout” and reserve lesson for their classrooms.

The website should fulfill the following requirements:

1. Website must be easy to use and accessible to both teachers and Cal Poly engineering student volunteers.
2. Integrate a computer database system that will store the following information:
  - E-Kit information: Lists all available kits provided by the E-Kit program.
  - Registration Profile: Ability to create profiles for teachers and student volunteers.

- Registered members have the ability to add, edit & delete profile information.
  - Student Profile Information
  - Teacher Profile Information
  - Reservation Information and Confirmation
3. Teachers should have the ability to login, browse available kits and reserve an experiment by choosing from a list of available lesson times.
  4. Students should have the ability to select experiments they would like to teach and provide date & time availabilities for teaching.
  5. When an E-Kit is reserved, that specific experiment should no longer appear as available, and the student reserved to teach that lesson should also no longer be available to teach any other lesson that same day.
  6. Website should be easy to maintain, update, and passed on to another Webmaster.



## IV. Design

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### E-KIT: SIMPLE ELECTROMAGNET EXPERIMENT

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The E-Kit developed as the experimental template is the Simple Electromagnet experiment. This experiment will be used as a basic template for the development of future E-Kits. The following describes the design of the Simple Electromagnet experiment created and tested for the teaching component of this outreach program.

#### *The Concept*

The main concept of the Simple Electromagnet E-Kit is to teach elementary school students about electromagnetism and how electricity is used to create a temporary magnet. This particular experiment is aimed to supplement the fourth grade science objectives regarding magnetism. The experiment will provide a way for students to explore the various properties of magnetism by building and testing the electromagnet built using an iron nail, copper wire and D-cell battery.

#### *Materials*

There are various options for the materials used to design the Simple Electromagnet E-kit. Table IV-I compares the various material to choose from and justification for why each of them would work in favor of the experiment or not.

**Table IV-1: Simple Electromagnet E-Kit Design Options**

Material Options	Justification
<b>Copper Wire</b>	
Enamel Coated Magnet Wire	<p><b>PROS:</b></p> <ul style="list-style-type: none"> <li>Easily accessible: can be purchased in reasonable spool lengths at the local Radio Shack or online.</li> <li>Perfect for winding tight coils and use for electromagnets.</li> </ul> <p><b>CONS:</b></p> <ul style="list-style-type: none"> <li>Difficult to see exposed copper wire when shaving off the clear enamel coating with emery board.</li> <li>Not reusable or easy to reshape after being wrapped around a nail.</li> <li>Does not allow the electromagnet to produce a strong enough electromagnetic field to pick up objects.</li> </ul>
Insulated Copper Wire	<p><b>PROS:</b></p> <ul style="list-style-type: none"> <li>Easily reshaped and can be reused</li> <li>Insulation can easily be removed to expose the copper wire.</li> <li>Allows electromagnet produce the proper strength to pick up more objects as more coils were wrapped around the iron nail.</li> </ul> <p><b>CONS:</b></p> <ul style="list-style-type: none"> <li>Difficult to find. This type of wire is not available in SLO and couldn't be found in small spools online.</li> </ul>
<b>Iron Nail</b>	
Galvanized Iron Nail	<p><b>CONS:</b></p> <ul style="list-style-type: none"> <li>Already partially magnetized.</li> <li>Not easily demagnetized.</li> <li>Does not pick up any of the magnetic testing materials.</li> </ul>
Iron Nail	<p><b>PROS:</b></p> <ul style="list-style-type: none"> <li>Easily magnetized.</li> <li>Correctly picks up magnetic testing materials.</li> </ul>
<b>Power Source</b>	
D-Cell Battery	<p><b>PROS:</b></p> <ul style="list-style-type: none"> <li>Provides enough power for the simple electromagnet to pick up testing materials.</li> </ul>
2 – Cell Batteries	<p><b>CONS:</b></p> <ul style="list-style-type: none"> <li>Provides too much power for the simple electromagnet.</li> <li>Quickly overheats the system.</li> </ul>
<b>Hold Circuit Connection</b>	
Use your fingers	<p><b>CONS:</b></p> <ul style="list-style-type: none"> <li>Difficult to hold connection together while trying to pick up testing materials</li> </ul>
Electrical Tape	<p><b>CONS:</b></p> <ul style="list-style-type: none"> <li>Doesn't provide a stable connection between copper wire and battery. Tape loses its adhesiveness after a few trials.</li> </ul>
Alligator Clips attached to ends of a battery holder	<p><b>PROS:</b></p> <ul style="list-style-type: none"> <li>Provides a stable connection between copper wire and battery.</li> </ul>

Based on the comparison and justification shown in Table IV-1 above, we can conclude that the following materials in Table IV-2 are best for developing the electromagnet and providing the appropriate basic functionalities of the simple electromagnet. The following table also lists testing materials that could be used.

**Table IV-2: Final Simple Electromagnet Materials**

Electromagnet Materials	Testing Materials
3 feet – Insulated copper wire	20 – Paper Clips
1 – Long iron nail	20 – Safety Pins
1 – D cell battery	1 – Compass
1 – D cell battery holder	

### *Objectives*

In order to successfully design an appropriate instructional manual and workbooks for the experiment, we must first take into account who the target audience of the lesson will be. For this example, the lesson plan is targeted towards a fourth grade level audience. Table IV-3 and Table IV-4 display the math & science standards that this electromagnet lesson aims to achieve. Table IV-5 provides a list of questions that are taken into account before developing the instruction manual and workbooks associated with the Simple Electromagnet E-Kit.

**Table IV-3: Simple Electromagnet E-Kit Fourth Grade Math Standards**

FOURTH GRADE MATH STANDARDS
<b>Algebra &amp; Functions</b> <ul style="list-style-type: none"> <li>1.0. Students use and interpret variables, mathematical symbols, and properties to write and simplify expressions and sentences.</li> <li>1.4. Use and interpret formulas to answer questions about quantities and their relationships.</li> </ul>
<b>Mathematical Reasoning</b> <ul style="list-style-type: none"> <li>2.3. Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models to explain mathematical reasoning.</li> </ul>
For Math Standards, refer to: <a href="http://www.cde.ca.gov/be/st/ss/documents/mathstandard.pdf">http://www.cde.ca.gov/be/st/ss/documents/mathstandard.pdf</a>

**Table IV-4: Simple Electromagnet E-Kit Fourth Grade Science Standards**

<b>FOURTH GRADE SCIENCE STANDARDS</b>
<b>Physical Sciences</b> <ul style="list-style-type: none"> <li>• <b>1.</b> Electricity and magnetism are related effects that have many useful applications in everyday life.</li> <li>• <b>1a.</b> Students know how to design and build simple series and parallel circuits by using components such as wires, batteries, and bulbs.</li> <li>• <b>1c.</b> Students know electric currents produce magnetic fields and know how to build a simple electromagnet.</li> <li>• <b>1e.</b> Students know electrically charged object attract and repel each other.</li> <li>• <b>1f.</b> Students know that magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.</li> </ul>
<b>Investigation &amp; Experimentation</b> <ul style="list-style-type: none"> <li>• <b>6c.</b> Formulate and justify predictions based on cause and effect relationships.</li> <li>• <b>6d.</b> Conduct multiple trials to test a prediction and draw conclusions about the relationships between prediction and results.</li> </ul>
<i>For Science Standards, refer to: <a href="http://www.cde.ca.gov/be/st/ss/documents/sciencetnd.pdf">http://www.cde.ca.gov/be/st/ss/documents/sciencetnd.pdf</a></i>

**Table IV-5: Questions to consider**

<b>SAMPLE QUESTIONS</b>
<p>Through several experiments and observations, students will be able to determine the following:</p> <ul style="list-style-type: none"> <li>• What affects the strength of the magnet?</li> <li>• Does wrapping around the more coils of wire increase or decrease the strength of the magnet?</li> <li>• Formulate an equation that represents the relationship of voltage, current, and the strength of the magnet.</li> <li>• Test the effects and result of magnetic poles by testing out various magnetic and non-magnetic objects. Why do some things repel and others attract? Why do some objects have weaker or stronger reactions to the magnet?</li> </ul>

### *Lesson Plan, Administrative Instruction Manual and Student Workbook*

Each experiment should provide an instructional manual for Cal Poly students administering the experiment. The manual includes a grade level appropriate lesson plan and step-by-step instructional workbook for the students in the classroom. The following shows a template of requirements for an E-Kit's lesson plan, administrative instruction manual and student workbook should focus on.

1. *Administrative Instructional Manual:*

- Provides the Cal Poly student volunteer with a checklist before administering the lesson and a brief overview of the experiment and lesson plan.

2. *Power point presentation:*

- Review magnetism and magnetic poles.
- Introduce electromagnetism and how it works.
- Show a working demo of the Simple Electromagnet experiment.

3. *Student Workbook:*

- A step-by-step instructional guide for assembling the simple electromagnet.
  - Provide photos to ensure specific steps in the instruction guide are clear.
  - Provide warnings and special notes. (I.e. Do not connect both ends of the alligator clips together, it will short your battery!)
- Include thinking questions and graphs:
  - Allow students to make hypothesizes and predictions to why things occurred after each significant step.
  - Allow students to discover the mathematical and scientific correlations between the number of wire turns and the number of paper clips and safety pins that can be picked up.

## INTERACTIVE WEB DATABASE & WEB-SERVER

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The Interactive Web Database and Web-Server design consists of a specific set of software criteria that must be satisfied in order to successfully develop an effective website that delivers all the requirements mentioned in the Requirements Section. Table IV-6 shows the various design decisions taken to develop the database integrated dynamic website.

**Table IV-6: Interactive Web Database & Web-Server Design**

Options	Justification
<b>Database Type:</b>	
Operational Dynamic Website	<b>Advantages:</b> <ul style="list-style-type: none"> <li>• Client/Server user ability</li> <li>• Allows users to add, change, and delete data</li> </ul>
<b>Operating System:</b>	
Windows XP	<b>Advantages:</b> <ul style="list-style-type: none"> <li>• <b>Easily accessible and easy to use.</b></li> <li>• <b>Commonly used:</b> There is more support and help for PHP and MySQL for a Window's environment.</li> </ul> <b>Disadvantages:</b> <ul style="list-style-type: none"> <li>• <b>It's not free.</b></li> </ul>
<b>Open-source Applications:</b>	
<ol style="list-style-type: none"> <li><b>1. PHP (Hypertext Preprocessor):</b> Provides the application part: a scripting language that is used to write the programs that perform dynamic tasks like moving data in and out of the MySQL database.</li> <li><b>2. MySQL (open source database software):</b> Provides the database part: the long-term memory Relational Database Management System (RDMS) that stores information for the web database application.</li> </ol>	<b>Advantages of using PHP and MySQL together:</b> <ul style="list-style-type: none"> <li>• <b>Cost Effective:</b> It's free.</li> <li>• <b>Web-oriented:</b> Specifically designed to focus on building dynamic web pages for user usability.</li> <li>• <b>Fast Speeds:</b> together they provide one of the fastest ways to deliver dynamic web pages to users.</li> <li>• <b>Portability:</b> Runs on many operating systems: Windows, Linux, MAC OSX, and Unix</li> <li>• <b>They communicate well with one another:</b> PHP has built in features to communicate with MySQL.</li> <li>• <b>Customizable:</b> Both open source applications allow programmers to easily modify it to fit the website's specific application needs and purpose.</li> <li>• <b>Wide base of support and help:</b> PHP &amp; MySQL are often used together so there are many tutorials available to reference.</li> </ul>
<ol style="list-style-type: none"> <li><b>3. Apache:</b> The web server software that delivers the web pages to the world.</li> </ol>	<b>Advantages:</b> <ul style="list-style-type: none"> <li>• <b>Cost Effective:</b> It's free.</li> <li>• <b>Portability:</b> Runs on many operating systems: Windows, Linux, MAC OSX, and Unix</li> <li>• <b>Popular:</b> At least 60% if websites use it.</li> <li>• <b>Secure &amp; Reliable:</b> Apache runs as much as the computer running it runs and problems are rare.</li> <li>• <b>Customizable:</b> Open source application that allows programmers to easily modify it to fit the website's specific application environment and purpose.</li> </ul>

## *WAMPserver*

Based on the design applications selected from *Table IV-6* above, installation of the WAMPserver software proved to be the easiest and best solution for setting up a local server on a Window's XP machine to host the E-Kit database system. The WAMPserver is a Windows based development environment that automatically installs Apache, PHP, and the MySQL database web applications and sets up a local server on your computer. The WAMPserver also includes the installation of the phpMyAdmin software that helps administrative user's to manage MySQL databases.

## *phpMyAdmin and MySQL*

PhpMyAdmin is a free software tool included with the WAMPserver installation. The purpose of phpMyAdmin is to simplify MySQL data basing my providing an easy-to-use user interface to manage MySQL database tables, data fields, and permissions. Selecting the phpMyAdmin environment makes it easy to create new and edit data fields in the database storage unit necessary for the E-Kit website. For the Interactive Web Database, the database tables hold the following information necessary for our system: student, profiles, teacher profiles, and E-Kit information. Table IV-7 and Table IV-8 are detailed lists of the information necessary to store in the E-Kit database:

**Table IV-7: MySQL Database Tables**

MySQL database information: Data that needs to be stored.	
<ul style="list-style-type: none"><li>• E-Kit information</li><li>• Student Information</li></ul>	<ul style="list-style-type: none"><li>• Teacher Information</li><li>• Appointment/Reservation Information</li></ul>

**Table IV-8: Required Data Fields for each Table in Database**

<b>PHP web pages: Required features of website pages</b>	
<b>REGISTRATION</b>	
<ul style="list-style-type: none"> <li>• <u>Account Type:</u> <ul style="list-style-type: none"> <li>○ Student</li> <li>○ Teacher</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <u>Contact Info:</u> <ul style="list-style-type: none"> <li>○ Name</li> <li>○ Phone #</li> <li>○ Email address</li> <li>○ Username</li> <li>○ Password</li> </ul> </li> </ul>
<b>STUDENT PROFILE</b>	
<ul style="list-style-type: none"> <li>• <u>Show/Edit General Contact Info:</u> <ul style="list-style-type: none"> <li>○ Name</li> <li>○ Email</li> <li>○ Phone #</li> <li>○ Username</li> <li>○ Password</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <u>Show/Edit Student Info:</u> <ul style="list-style-type: none"> <li>○ Major &amp; Class Level</li> <li>○ Travel Location Limit/Area Preference</li> <li>○ Additional Notes</li> </ul> </li> <li>• Set Lesson Availability</li> <li>• View Confirmed Reservations</li> <li>• Deactivate Account</li> </ul>
<b>TEACHER PROFILE</b>	
<ul style="list-style-type: none"> <li>• <u>Show/Edit General Contact Info:</u> <ul style="list-style-type: none"> <li>○ Name</li> <li>○ Email</li> <li>○ Phone #</li> <li>○ Username</li> <li>○ Password</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <u>Show/Edit School/Classroom Info:</u> <ul style="list-style-type: none"> <li>○ School Address</li> <li>○ Classroom Location</li> <li>○ Subject</li> <li>○ Grade Level</li> <li>○ Additional Notes</li> </ul> </li> <li>• View Confirmed Reservations</li> <li>• Deactivate Account</li> </ul>
<b>EXPERIMENT PAGES</b>	
<ul style="list-style-type: none"> <li>• Experiment Description</li> <li>• Objectives Addressed</li> </ul>	<ul style="list-style-type: none"> <li>• Materials being used</li> <li>• Reservation Button</li> </ul>
<b>RESERVATION PAGE “Shopping Cart”</b>	
<ul style="list-style-type: none"> <li>• View E-Kit Selection <ul style="list-style-type: none"> <li>○ Experiment</li> <li>○ Description</li> </ul> </li> <li>• Make an appointment: <ul style="list-style-type: none"> <li>○ A list of students &amp; times will be available to choose from</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Verify location</li> <li>• Special Notes</li> <li>• Confirm Reservation</li> </ul>
<b>CONFIRMATION PAGE “Checkout Confirmation”</b>	
<ul style="list-style-type: none"> <li>• <u>Experiment Reserved</u> <ul style="list-style-type: none"> <li>○ Name &amp; Description</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <u>Appointment Info:</u> <ul style="list-style-type: none"> <li>○ Date and Time</li> <li>○ Location</li> <li>○ Student Administering Lesson: Student Contact Info</li> </ul> </li> </ul>



In addition to the required web pages necessary for the teacher and Cal Poly student volunteers to access and store information on the website. An administrative page is also designed to allow E-Kit Program administrators to manage data in the database. The requirements for these pages are listed in Table IV-9 below.

**Table IV-9: Administrative Page Requirements**

ADMINISTRATIVE PAGES	
<ul style="list-style-type: none"> <li>• <u>Database Manager</u> <ul style="list-style-type: none"> <li>○ View &amp; Edit the following: <ul style="list-style-type: none"> <li>▪ Admin Accounts</li> <li>▪ Member Accounts</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>○ Add, View &amp; Edit the following: <ul style="list-style-type: none"> <li>▪ E-Kits</li> <li>▪ Confirmed Reservations</li> </ul> </li> </ul>

### *Web Design Interface*

The web interface will have the following basic design shown in Figure IV-1. The main goal of this interface to implement a user-friendly design that allows users to easy navigate through and perform the basic functions of logging in, browsing the catalog and making reservations.

The screenshot displays the Cal Poly SLO e-kits website interface. At the top, the header includes the Cal Poly SLO logo, a lightbulb icon, and the text 'e-kits'. A 'Welcome!' message with links for 'login' or 'register' is on the right. Below the header is a navigation bar with links for 'home', 'about us', 'e-kits', and 'contact us', along with a search bar. The main content area is divided into two sections. On the left, under 'BROWSE CATAGORIES', there is a 'By Subject:' section with links for 'Math', 'Science', and 'Math & Science'. The right section is titled 'E-Kit Registration' and contains a form with the heading 'Hello! Ready to register with Cal Poly E-kits?'. The form includes fields for 'Type' (a dropdown menu set to 'student'), 'First name:', 'Last name:', 'Email:', 'Phone:', 'Username:', and 'Password:'. A 'Complete Registration' button is located at the bottom of the form. A footer at the very bottom contains links for 'home', 'about us', 'e-kits', 'sitemap', and 'contact us'.

**Figure IV-1: Interactive Web Database Interface**

## V. Development

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With the help of the design requirements and criteria discussed in Sections II and III, we are provided with the basic layout for the development process. The E-Kit project's development focuses on the two following phases:

1. Building and testing of a sample E-Kit template. For this example, the development of the Simple Electromagnet experiment and its corresponding lesson plan.
2. Implementation of the Interactive Web Database and Web-Server Installation.

### E-KIT: SIMPLE ELECTROMAGNET EXPERIMENT

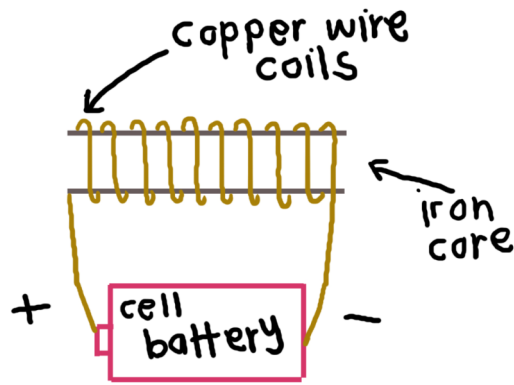
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The initial development phase involves the creation of the Simple Electromagnet E-Kit. This process includes the assembly of the Simple Electromagnet experiment, a corresponding lesson plan, and instructional workbook that will be used as a model for the development of future E-Kits.

#### *Assembling the Simple Electromagnet E-Kit*

The initial inspiration for selecting the Simple Electromagnet as the model E-Kit come from personal experiences of a participating in a similar electromagnet experiment in my fourth grade gifted in talented class. An experience I strongly remember and enjoyed. The basis of the experiment's development and design was taken from what I can remember from this experience. Additional research was done to ensure each of the materials purchased for the electromagnet is properly selected to provide the best results and outcome.

The basic structure and design of the Simple Electromagnet E-Kit involves building a simple closed circuit using insulated copper wire wrapped around a long iron nail, powered by a D-cell battery (Figure V-1).



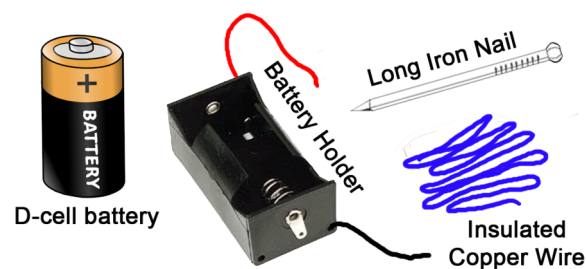
**Figure V-1: Simple Electromagnet Schematic**

*Problems:*

Before producing the final electromagnet experiment used in an elementary school classroom to teach students about magnetism and electromagnetism, a few trials and errors were encountered. One of the major problems encountered during the development of the Simple Electromagnet was finding the proper materials that successfully achieve the functions of the experiment. Given the limited resources and electronic stores available in San Luis Obispo, finding the appropriate copper wire and iron nails were difficult. As a result, the initial prototype failed using a galvanized iron nail and enamel coated magnet wire that was readily available in local stores. The result of using these materials did not satisfy the end goals of the electromagnet experiment. The combination of the galvanized iron nail and enamel coated magnet wire were unable to pick up objects or create a strong enough magnetic field. This made it impossible to observe the relationship between the number of wire coils wrapped around the nail and the number of objects that the electromagnet can pick up.

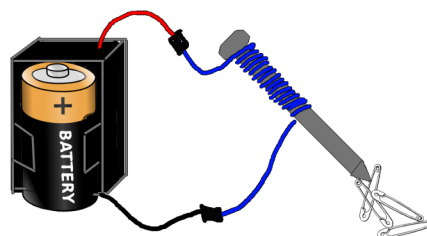
*Solutions:*

After a few trials and errors with various types of nails and wires, the final electromagnet experiment was created using a regular iron nail and insulated copper wire (Figure V-2). With these materials in the E-Kit, students will be able to assemble the electromagnet and begin testing its powers on the test materials (safety pins, paper clips, and compass) provided in the E-Kit to observe the strength of the electromagnet.



**Figure V-2: Final Materials for Simple Electromagnet E-Kit**

In addition to the basic function needs of the Simple Electromagnet, an additional component was added to allow testing and use of the electromagnet a little easier for elementary school student hands. Including a battery holder is not an essential component for the electromagnet, it makes it easier to make open and closed circuit connections to switch the electromagnet ON/OFF. Providing this helps the avoid any troubles concerning holding the wire ends of the copper wire to the battery together and feeling the heat of the battery on your fingers (Figure V-3).



**Figure V-3: Final Simple Electromagnet E-Kit**

## *Creating a Lesson Plan*

The lesson plan for the Simple Electromagnet E-Kit involves a simple review of magnetism and magnetic pole properties. The power point presentation also introduces the concept of electromagnetism and how they are used and benefit everyday life. Basic properties of an electromagnet will be discovered during assembly of the experiment.

To ensure that students find the presentation interesting and entertaining, various animations and visual examples are included to illustrate basic ideas such as the magnetic properties of attracting and repelling poles. Including questions that involve student participation also helps the class be more involved with the lesson. This allows the students to think about ideas being presented and develop hypotheses and predictions as to why each end of the magnet reacts the way it does or what objects are examples of electromagnets.

- To view the lesson, **See Appendix D: Simple Electromagnet Power Point Presentation.**

## *Workbook*

The goal of the workbook is to provide both the Cal Poly student volunteer and the elementary school students with a set of step-by-step instructions to follow to build the simple electromagnet. In addition to providing a step-by-step instruction set, each workbook includes a set of questions and graphs that pertain to specific developments in the experiments that should be observed and discussed.

For example, what happens when you move the electromagnet towards to the paperclips before connecting the ends of the copper wires to the battery? Why do you think this happened? What happens after you connect the ends of the copper wire to the battery? What changed, and why? Mathematical expressions and graphs can also be included to help students develop and

observe the relationships with the number of wire coils wraps around the iron nail and the strength of the electromagnet.

*Problems:*

A few problems encountered during the development of the electromagnet workbook was creating a set of step-by-step instructions that is easy for both the Cal Poly student volunteer and the elementary students to understand and follow. The most challenging part of preparing the workbook is providing a grade level appropriate set of instructions and format enough space for students to answer questions and fill in graphs. The assumption that the instructions are simple, still may not be as easy to understand and follow.

*Solutions:*

The best way to ensure that the workbook is user appropriate, break up the steps into short and simple sentences. Also including images to illustrate various steps can be helpful for students to follow, especially when they are attempting to perform the experiment for the first time.

- To view the electromagnet workbook, **See Appendix E: Simple Electromagnet Workbook**

## INTERACTIVE WEB DATABASE & WEB-SERVER

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There are three main parts to the developmental process of the Interactive Web Database and Web-Server design. This section includes information for development approaches to the following three essential parts necessary to complete the E-Kit's database website:

1. WAMPserver installation.
2. Setting up the database using phpMyAdmin and MySQL.
3. Building the website's user interface with Adobe Dreamweaver.

### *WAMPserver Installation*

The initial approach to the WAMPserver installation was to individually install all three of the open-source software: Apache, PHP, and MySQL on a virtual machine running Windows XP.

### *Problems:*

After failing to successfully configure the open-source software individually, the next approach was to request a virtual machine provided by the Cal Poly Computer Department Systems Laboratories (CSL) running Windows Server 2000 with the WAMPserver pre-installed. However, after successfully receiving access to the virtual Windows machine, I discovered working in this virtual environment from a MAC OSX machine extremely difficult. The response time of the virtual machine was too slow to make any progress on the developing the Interactive Web Database. The virtual machine would constantly disconnect and hinder the WAMPserver from running properly. Constant troubleshooting was attempted to fix the problem until finally a

new approach was discovered to help progress on the development and implementation of the website.

#### *Solutions:*

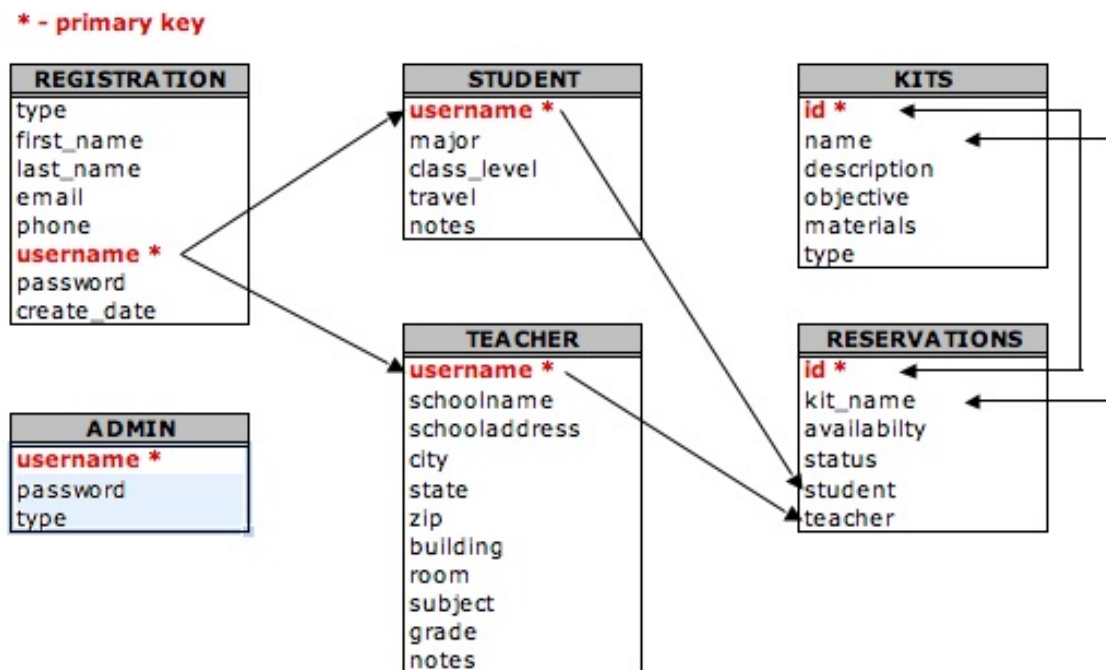
The solution to this problem involved the installation MAMP, the MAC OSX based software that installs Apache, MySQL, and PHP on my local machine. However, due to portability issues, the MAMP attempt proved to be unbeneficial. As a result, the final attempt includes the creation of a virtual Windows XP machine on my computer and installation of the WAMPserver software in this environment. The WAMPserver installation completed without any trouble which allowed development on the database and website to run more smoothly.

- For more information about installing a WAMPserver: **See Appendix A: WAMPserver Installation Guide**

#### *phpMyAdmin and MySQL*

The main approach to using the phpMyAdmin software is to learn and take advantage of its simple easy-to-use interface for building a MySQL databases. Using the phpMyAdmin environment makes it easy to build the necessary database tables required for the E-Kit website. Creating the tables for the E-Kit web database was modeled after Adobe Dreamweaver's "How to build your first dynamic website" step-by-step tutorial, which can be found at [http://www.adobe.com/devnet/dreamweaver/articles/first\\_dynamic\\_site\\_pt1\\_06.html](http://www.adobe.com/devnet/dreamweaver/articles/first_dynamic_site_pt1_06.html). Figure V-4 illustrates the relationship between the various tables and the information stored in the E-Kit database website.





**Figure V-4: E-Kit database tables and data fields**

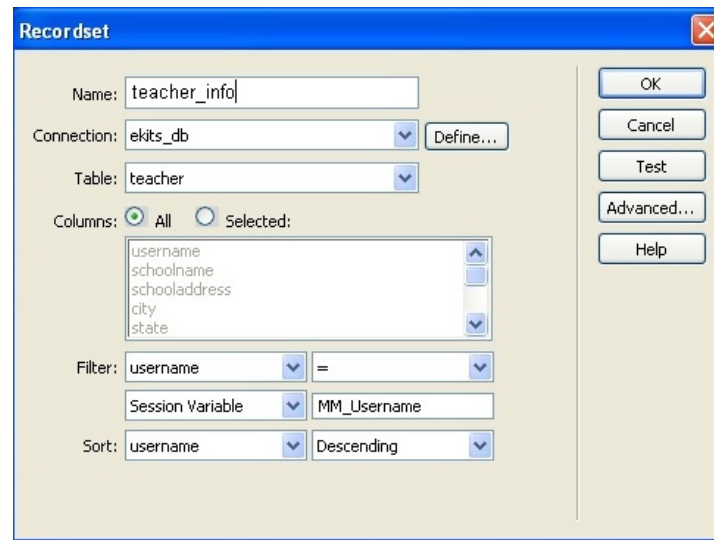
#### *Problems:*

One of the main issues encountered during the development of the E-Kit database system involves the understanding of how to group data fields and link related database tables together. For example, the two separate tables, `REGISTRATION` and `TEACHER` both require a shared reference to the same `USERNAME` data field (Figure V-4). For this example, the ability to link the `USERNAME` data field is important for accessing and manipulating the correct data entered when creating the new teacher profile entry.

#### *Solutions:*

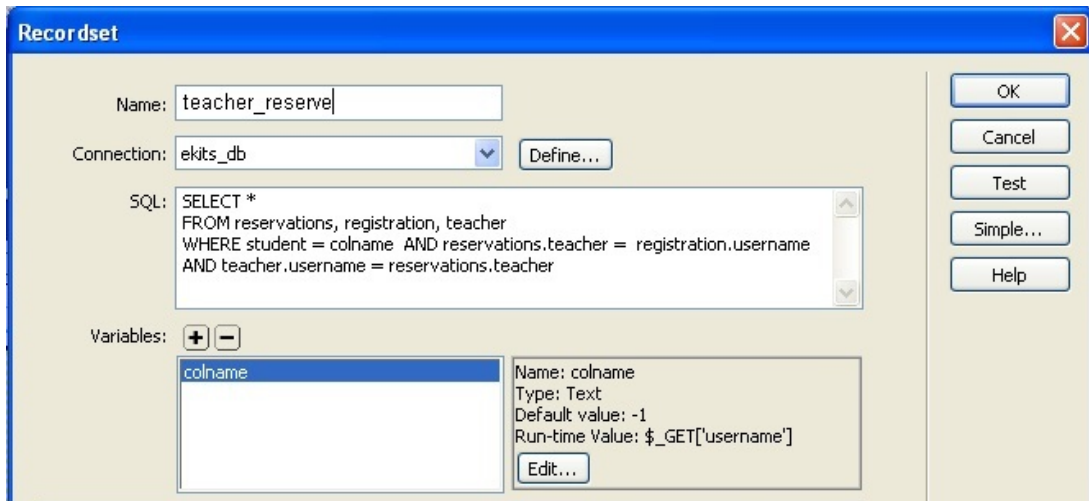
There are two main cases to consider when building relationships and linking tables in a database: linking between two database tables and linking between multiple database tables. The solution to linking two different tables, for example `REGISTRATION` and `TEACHER`, requires setting the primary key of each of these tables to the same data field `USERNAME` (Figure V-4).

Giving both tables a `USERNAME` data field will help administrative managers of the database to recognize the relationship and link them using the SIMPLE FILTER ability in the Adobe Dreamweaver environment (Figure V-5).



**Figure V-5: Setting a simple filter to link two database tables**

The second case concerns the linking of multiple tables. For example in order to properly access a specific reservation entry in the `RESERVATION` table, we need to access the proper `EKIT ID`, `EKIT_NAME`, `STUDENT_USERNAME`, and `TEACHER_USERNAME` associated with that particular reservation. In order to properly link these tables and access the data in the specified reservation entry, the following SQL changes are made in the ADVANCED FILTER section in Adobe Dreamweaver environment (Figure V-6).



**Figure V-6: Setting an advanced filter to link multiple database tables**

- For more information on creating a MySQL database using phpMyAdmin: **See Appendix B1, Step 4: Creating a database**

### *Adobe Dreamweaver*

The original attempt to build the interactive web database involved learning the PHP syntax and hard-code the PHP web pages individually to integrate the MySQL database tables into a dynamic user-friendly website interface. However, the discovery of Adobe Dreamweaver's easy-to-use user interface and readily available tutorials became the more appropriate approach to developing the website. The Adobe Dreamweaver environment comes ready with the capability to configure and integrate PHP syntax and MySQL databases for building dynamic websites. Given the numerous tutorials and resources available for help online, it was easy to learn and become comfortable with to create the final user-interface for the interactive E-Kit database website.

### *Problems:*

With no previous experience and knowledge in working with the Adobe Dreamweaver environment, the main problem encountered during the development phase of the database website was getting started and learning how to navigate and use the program. As previously described in Section B: phpMyAdmin and MySQL, one of the greatest challenges encountered during development of the website concerned creating multiple relationships and linking multiple database tables using the Filter functions in Adobe Dreamweaver.

### *Solutions:*

Again, with the help of Adobe Dreamweaver's "How to build your first dynamic website" tutorial and many trials, the ability to link multiple tables was successfully achieved. After becoming more comfortable and moving over the learning curve of using the Adobe Dreamweaver environment, progress on the website implementation moved more smoothly and swiftly. However, if given more time to focus on the database phase of the project, the final result of the website would have been much more user-friendly and functional.

- For more information on creating a MySQL database using phpMyAdmin: **See Appendix B2: Maintaining the website using Adobe Dreamweaver**

## VI. Testing

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The testing approach for each of the two main components of the Elementary Electronic Kit and Interactive Web Database project involves basic use of them. By allowing friends and elementary students to perform the Simple Electromagnet experiment and log-on to the web database, we are able to discover issues that need to be revised or improved. The following sections describe how each of the two components are tested, what problems were encountered, and how the problem are solved.

### E-KIT: SIMPLE ELECTROMAGNET EXPERIMENT

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Before going out and testing the lesson and experiment on elementary school students, it is necessary to ensure that the instructional workbook and experiment was grade level appropriate and easy to understand. The first testing step included asking friends and co-workers (not majoring in engineering) to complete the electromagnet experiment by following the instructional steps in the workbook that was intended for a fourth grade student audience.

Revisions and alternate experiment designs are based on questions, feedback and observations made during these tests to accommodate any areas of confusion or difficulty. One of the major issues encountered in these tests involves the word choices used in the instructions were too advanced for non-engineers to understand. Also the requests to include additional images to illustrate steps in the instructions were made to make the instructions easier to understand and follow.

The next step to testing the teaching component of the project is to go out and teach a classroom of elementary school students. The first teaching experience proved to be a great learning experience and reflection of the overall E-kit development thus far. One of the major

problems encountered during the live demo of the teaching portion was predicting how the fourth graders would react to the experiment's instructions and how much freedom was given to them to perform the experiment on their own. By allowing the students to work on their own, it gave them the freedom to explore the properties of the electromagnet materials more but also revealed a few safety hazards that had not been anticipated. For example, some groups followed the instructions accordingly and step-by-step, while others did not. Also without any prior warning, some groups began to short the batteries by connecting the alligator clips at each end of the battery together. Luckily, I was prepared with a few extra batteries to allow the groups to continue the experiment.

After this lesson, observations showed that there are still many aspects of the lesson that needs to be improved and further studied. Unfortunately, another opportunity to teach another class this quarter was not possible to allow testing any revisions to the lesson plan and presentation. Another major improvement that needs to be addressed is the power point presentation given at the beginning of the class to introduce the topics of magnetism and electromagnetism. Although the presentation was entertaining, educational and provided the basic knowledge necessary for completing and understanding the experiment, I was not completely prepared for the questions the students asked afterwards. As a result, a few of the responses I made were incorrect. For future lessons, student volunteers should be prepared to answer questions regarding the experiment not discussed in the presentation. As more experiments and kits are added to the program, student volunteers will continue to learn and observe new ways to improve the teaching process and the way experiments are administered for the next class visit. A set of questions can also be combined after each lesson to help other volunteers to prepare for future teaching opportunities.

- For the sample lesson script, **See APPENDIX F: Administrative Checklist & Sample Lesson Script**

## INTERACTIVE WEB DATABASE & WEB-SERVER

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Similarly to the testing approach for the Simple Electromagnet experiment, the most basic and effective testing approach for the Interactive Web Database is to use it. Throughout its development and implementation, intensive testing of each page's functionality was done to ensure all pages linked properly and achieved the appropriate tasks, requirements, and design discussed in Section II and III.

After completing the interactive web database, allowing friends to register and log into the website helped to determine and discovery broken links and bugs in the system. Based on their observations and feedback, revisions and changes were made to accommodate their requests and improve the website's functionality and satisfy user usability.

## VII. Conclusion

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### THE FUTURE OF E-KITS

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The final result of the Elementary Electronic Kits and Web Database project successfully satisfied the minimum proposed requirements. However, there are many improvements that can be made to complete the overall functionality of the system. With more time, knowledge and experience, the Web Database could function more smoothly and professionally achieve the original design ideas and requirements presented during Senior Project I. The TABLE 7.1 below shows a few additional features that can be implemented in the future.

With a basic structure and templates provided by this Senior Project, the future of the E-Kit program depends on the interest and dedication of future Cal Poly students willing to continue the outreach program. The goal of this project is provide the initial basis of the outreach program and hand it over to IEEE, SWE, and other clubs on campus to continue building upon. Future students will have the freedom to create new kits and lesson plans that would be appropriate for elementary school students following (or improving) the same template format provided by the Simple Electromagnet kit developed for this project. A website administrator will also be required to maintain the database, to add information about new E-kits and improve the functionality of the website. Eventually, Cal Poly student volunteers will be compensated with gifts from sponsors who donate gift certificates or coupons in exchange for their service to the community.

**Table VII-1: Future Features**

Possible Future Interactive Web Database Features	
<ul style="list-style-type: none"><li>• Newsletter/Mailing List<ul style="list-style-type: none"><li>○ E-Kit updates and additions</li></ul></li><li>• Secret Question for Security</li><li>• Login/password retrieval (If forgotten)</li></ul>	<ul style="list-style-type: none"><li>• Search Bar</li><li>• Site Map</li><li>• Automatic distance matching &amp; mapping</li><li>• Recommended grade levels for experiments</li></ul>



## APPENDIX A: WAMP server Installation Guide

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The following is a step-by-step instructional guide for installing Apache, MySQL and PHP software and setting up our own server on your Windows XP machine using WAMP.

### 1. Download WAMP

- Go to <http://www.wampserver.com/>
- Click Downloads & download the newest version of WAMP → 2.0i

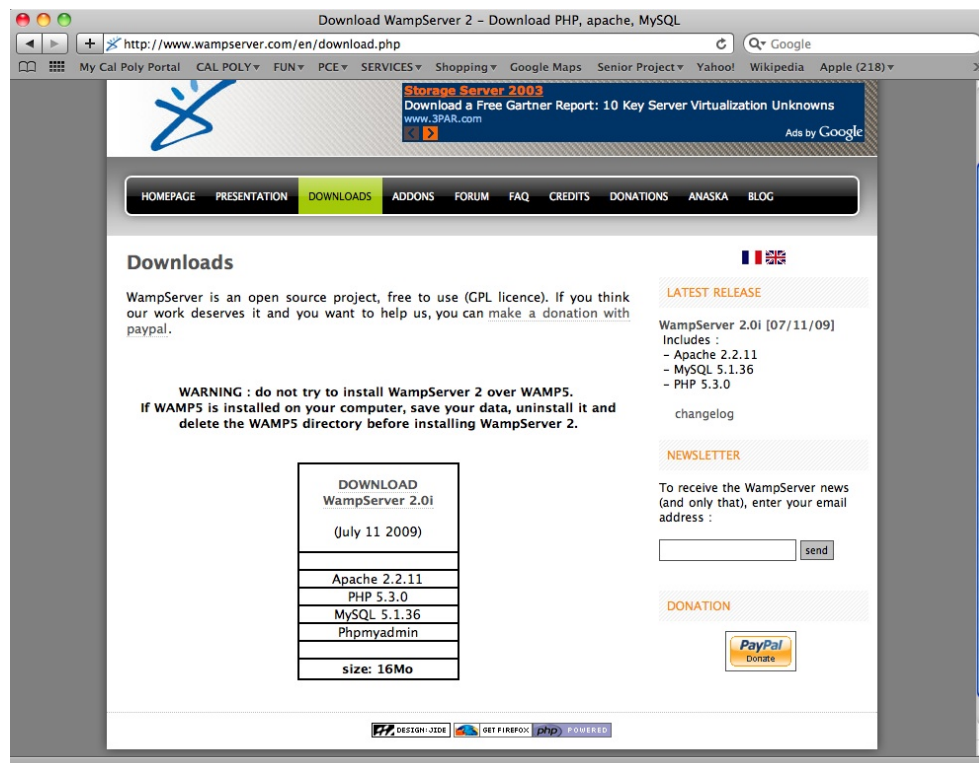


Figure A-1: WAMP server download website

### 2. Install WAMP

- Double click on the WAMPserver2.0i Setup icon



Figure A-2: WAMP server setup icon

- Install WAMP by following the WAMP directions

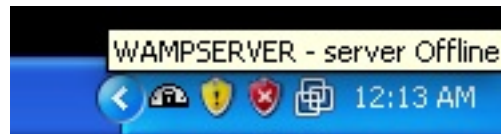
### 3. Start WAMP Server

- Start > All Programs > WampServer > start WampServer



**Figure A-3: WAMP server startup icon**

- You should see the WAMPServer tray icon in the System Tray area on the right bottom corner of your desktop

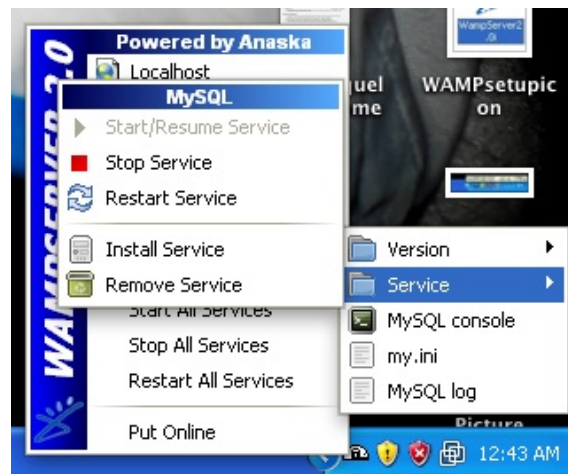


**Figure A-4: WAMP server system tray icon**

If problems occur where the WAMP server icon doesn't turn completely white with a black icon image in the center at startup. Please check the following:

### 4. Make sure both MYSQL & APACHE were successfully installed.

- Left click WAMP server tray icon & select the following:
  - MYSQL > Service > Start/Resume Service



**Figure A-5: MySQL system tray menu**

- Apache > Service > Start/Resume Service

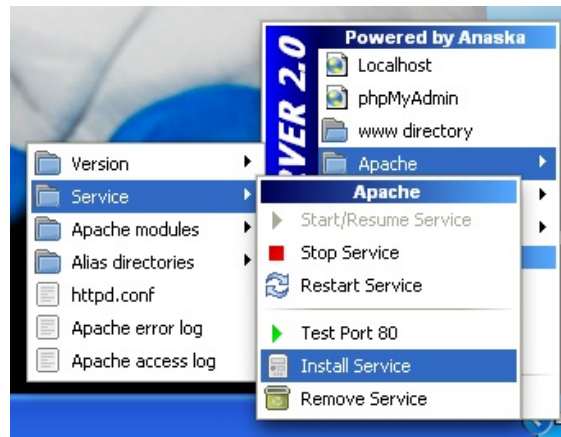


Figure A-6: Apache system tray menu

- If neither of these are clickable. Select **Install Service**

## 5. Test WAMP

- Open your internet browser and go to <http://localhost/>

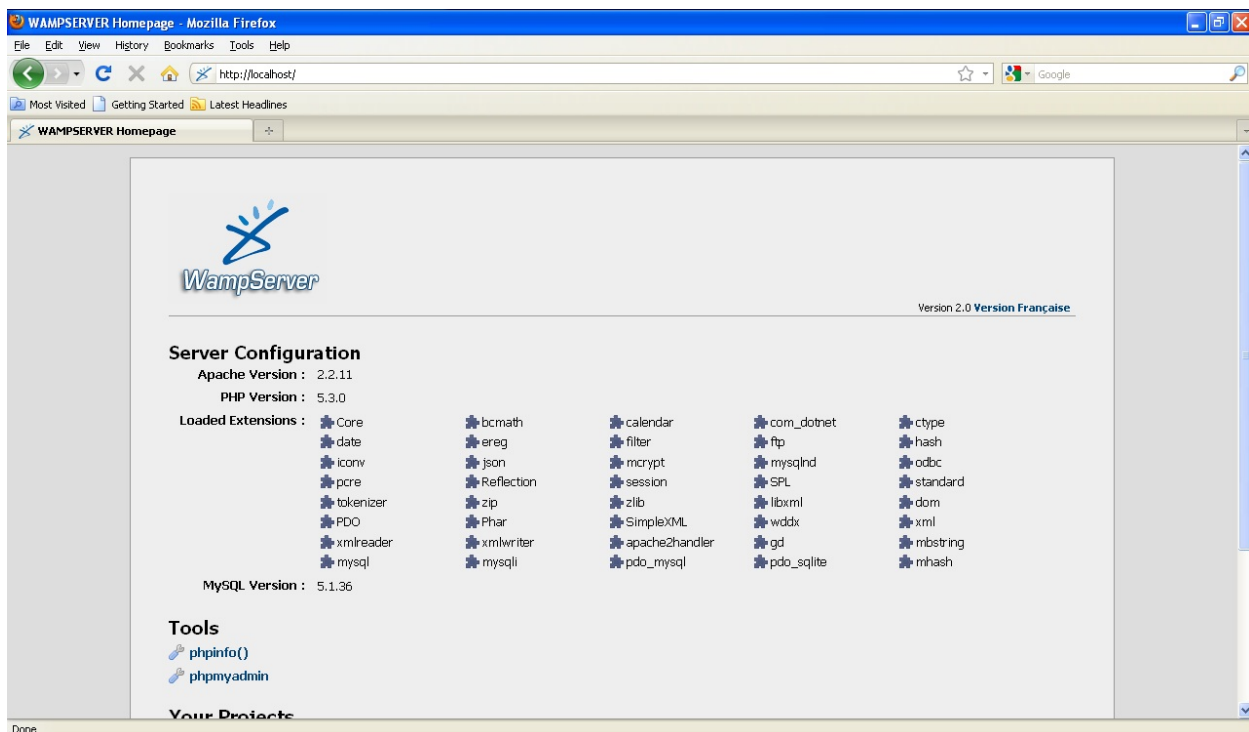


Figure A-7: WAMP local host test website

## APPENDIX B: Web Development & Maintenance

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### ADDING THE WEBSITE TO YOUR SERVER

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The following is a step-by-step instructional guide to adding the existing website files to the WAMP server on your local machine.

#### 1. Start your WAMP server

- Refer to APPENDIX A, STEP 3

#### 2. Open your www folder

- Click on the WAMP server system tray icon on the right corner of your desktop and select **www directory**.



Figure B-1: Open your www folder

- This will open the location of your WAMP server's www folder on your desktop

#### 3. Drag the Ekits and Ekit data folders into your www folder

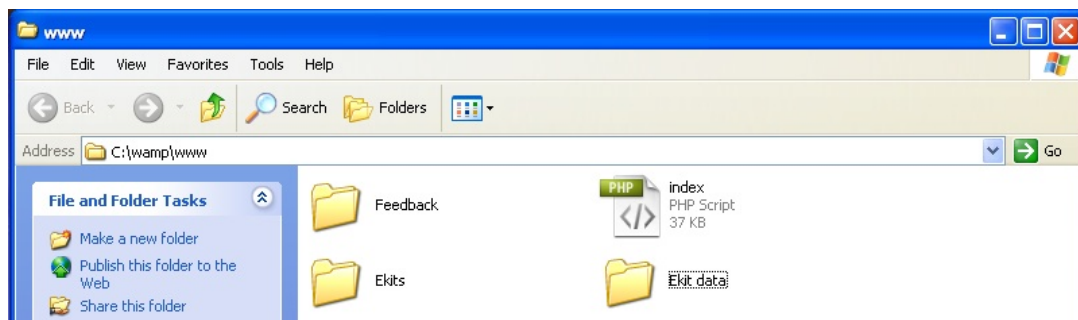


Figure B-2: Place Ekit folders into WAMP www directory

#### 4. Create a new database

- Open up phpMyAdmin by clicking on the WAMP server system tray icon on the right corner of your desktop and select **phpMyAdmin**.

*Note: You can also access this page by typing <http://localhost/phpmyadmin> into your internet browser.*

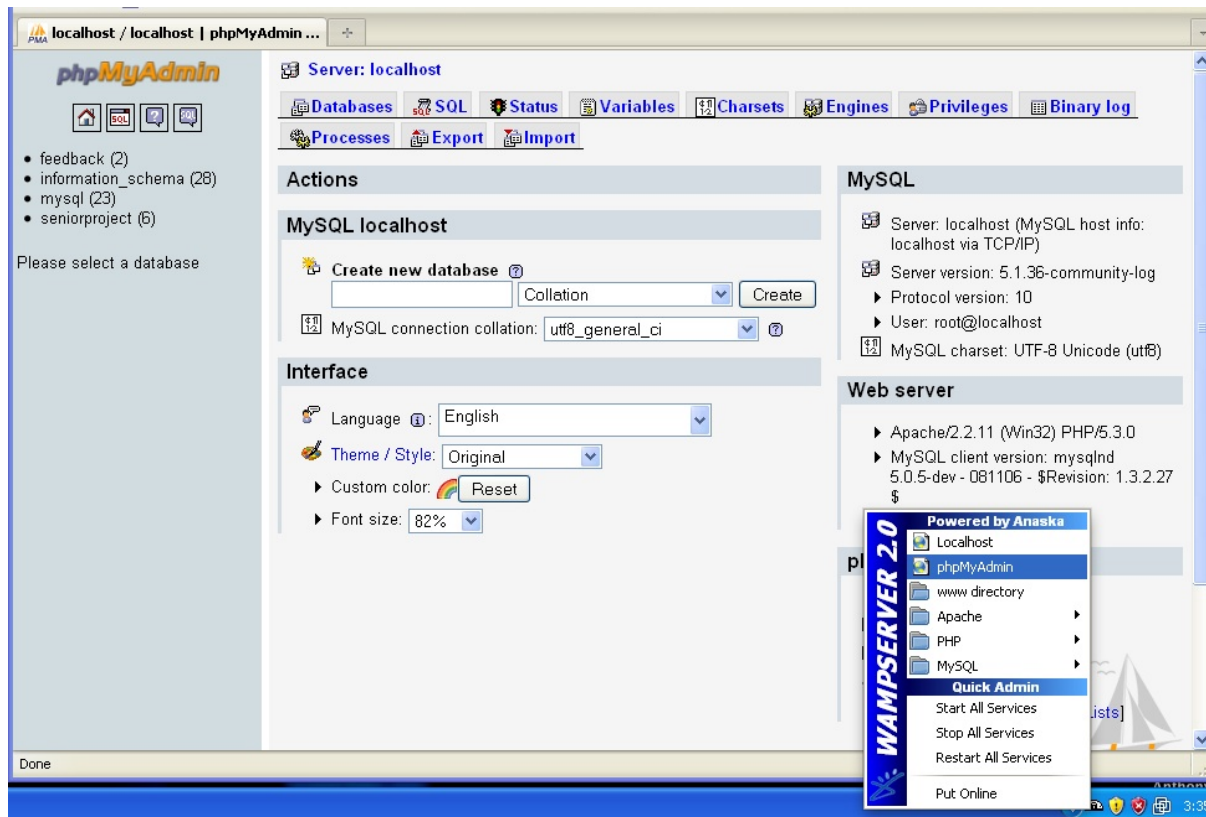


Figure B-3: Open phpMyAdmin

- Enter **seniorproject** into the textbox labeled Create new database and click **Create**

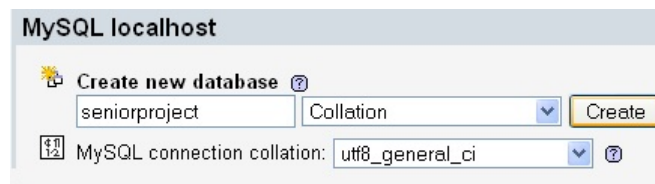


Figure B-4: Create a new database

## 5. Import data into database


- Click import tab at the top of the page.



Figure B.5: Import database data

- Click Browse and locate the Ekit data folder on your computer.  
**C:\wamp\htdocs\Ekit\_data**
- Select the file **ekits.sql**
- Click **GO** at the bottom of the page.

## 6. Create a MySQL user account

- Click on the  icon on the left-hand side of the phpMyAdmin window.
- Click the **Privileges** tab at the top of the screen.
- Click **Add a new user**
- Enter **ekit\_user** in the User name text box.
- Select **Local** from the Host drop-down menu.
- Type a password into the Password field & the same password into the Re-Type field  
For this example, use the **password: calpolyslo**
- Click **GO** at the bottom of the page

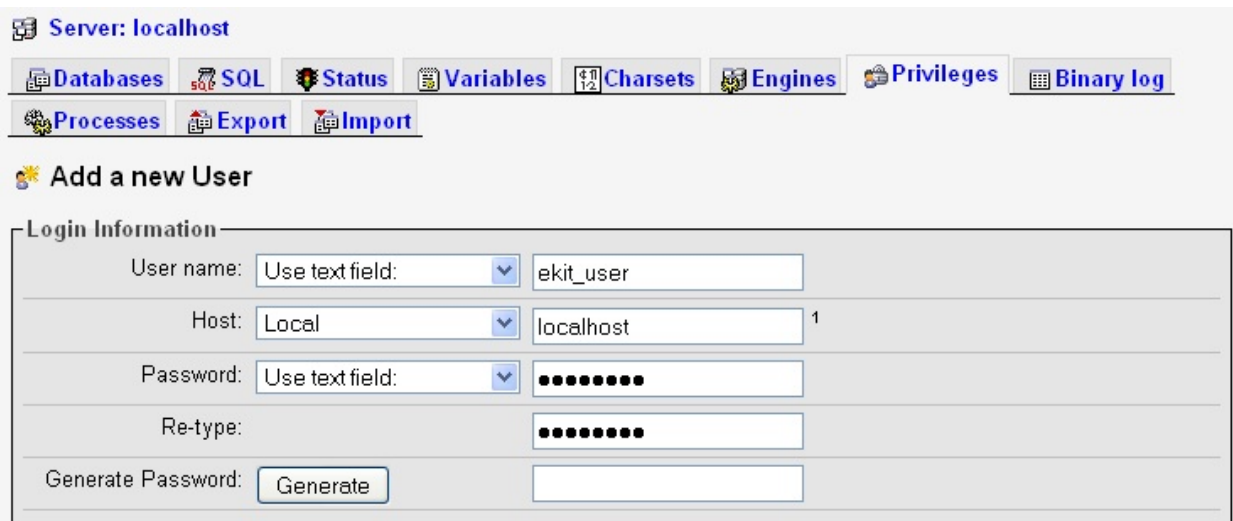
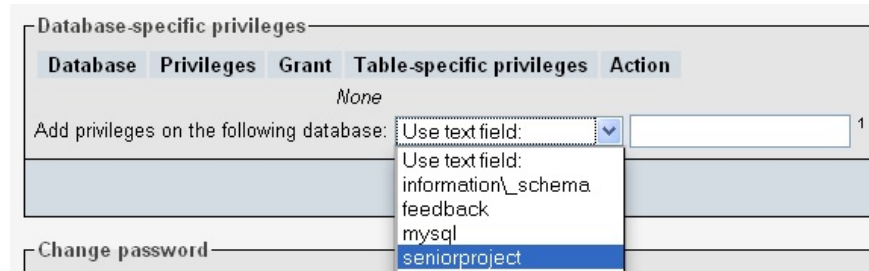


Figure B-6: Add new MySQL user account

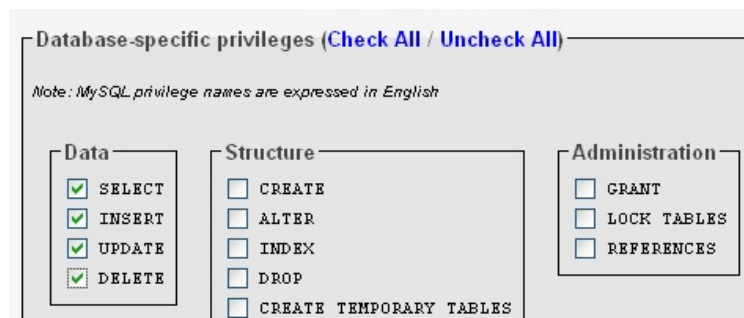
## 7. Set database privileges

- In the new user confirmation page, scroll down to the **Global privileges section** and select **seniorproject**.



**Figure B-7: Set Global privileges**

- You will be redirected to a page where you can set the user's privileges. Select the SELECT, INSERT, UPDATE, and DELETE.



**Figure B-8: Set User Privileges**

- Click **GO**.

## CONGRATULATIONS!

You have now successfully set up the web database on your local computer. Proceed to the next page to configure your website's database with Adobe Dreamweaver.



## CONFIGURING & CONNECTING THE DATABASE IN ADOBE DREAMWEAVER

---

The following is a step-by-step instructional guide for configuring the database website with Adobe Dreamweaver.

### 1. Start up Adobe Dreamweaver

*NOTE: If you do not have Adobe Dreamweaver, it can be downloaded for a free 30-day trial from <http://www.adobe.com/products/dreamweaver/?promoid=BPDEC>*

### 2. Setting up your workspace

- Select the Window tab > Workspace Layout > Classic

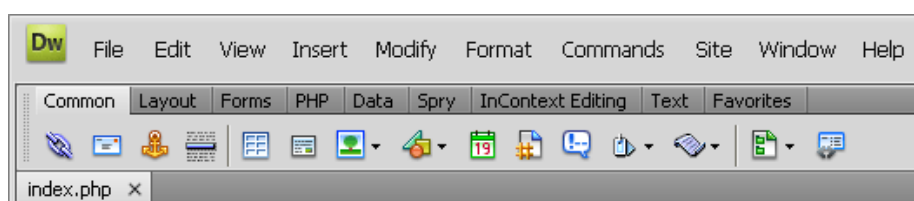


Figure B-9: Adobe Dreamweaver Toolbar

### 3. Install the project files

- Select Site > New Site > Advances tab

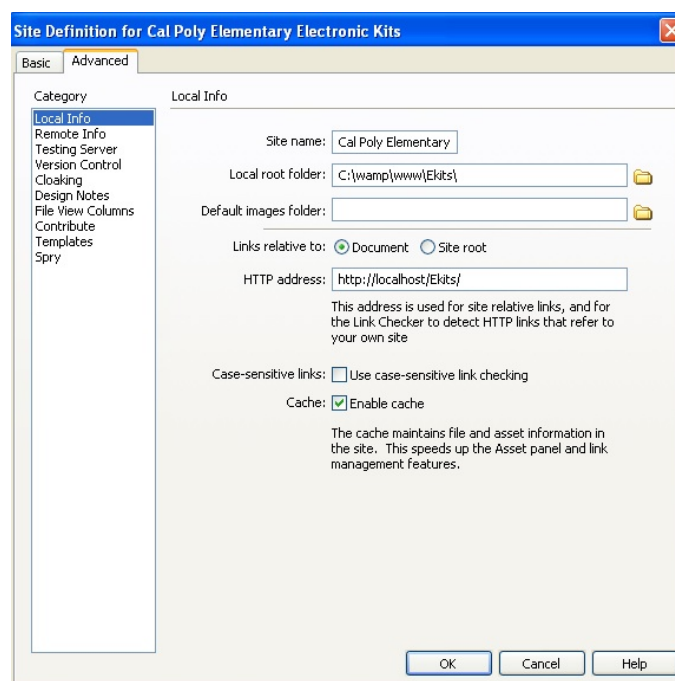
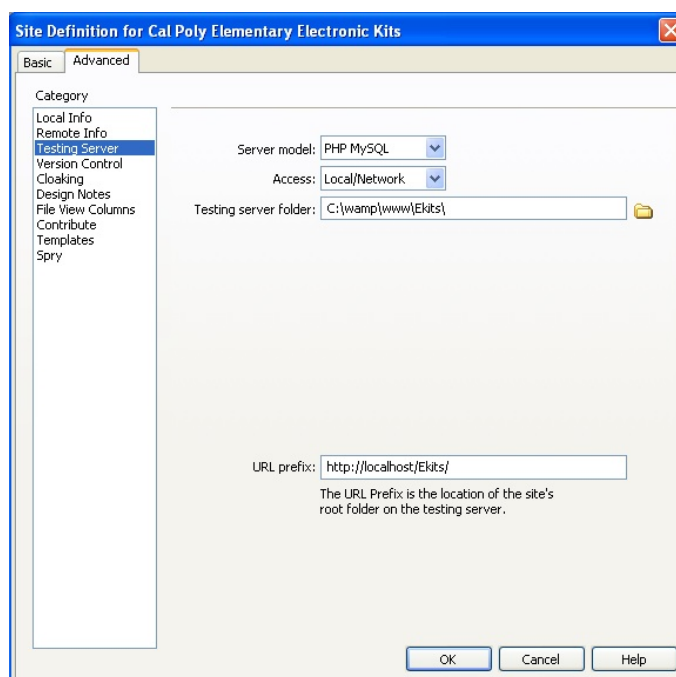


Figure B-10: Specifying your working folder



- Select **Local Info** from the list of categories on the list hand side of the Site Definition Window.
- Enter the following information into the data fields:
  - **Site name:** Cal Poly Elementary Electronic Kits
  - **Local root folder:** C:\wamp\www\Ekits\
  - **Links relative to:** select Document
  - **HTTP address:** <http://localhost/Ekits/>
- Leave the remainder of the window as is and select **Testing Server** from the list of categories on the left hand side.



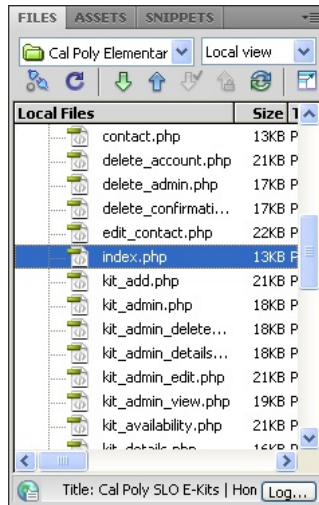
**Figure B-11: Specifying your test server**

- Enter the following information into the data fields:
  - **Server model:** PHP MySQL
  - **Access:** Local/Network
  - **Testing server folder:** C:\wamp\www\Ekits\
  - **URL prefix address:** <http://localhost/Ekits/>
- Click **OK** and **DONE**.

#### 4. Connect the Database

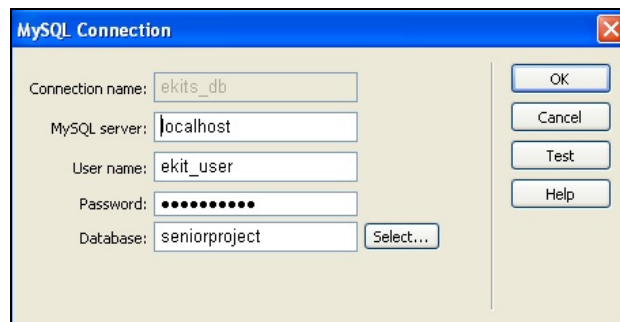
Using the database information created in phpMyAdmin.

- Locate the Files panel on the bottom right-hand corner of your Adobe Dreamweaver window and double click on the **index.php** file.



**Figure B-12: Files panel**

- In the Database panel, click the (+) button and select **MySQL Connection**.
- Enter the following information in the data fields:
  - **Connection name:** ekits\_db
  - **MySQL server:** localhost
  - **User name:** ekit\_user
  - **Password:** calpolyslo
  - **Database:** seniorproject



**Figure B-13: Making a MySQL Connection**

- Click **Test**. If test fails, please make sure all the information you entered are correct and match the information entered when you created the database in phpMyAdmin.
- Click OK. Select File > Save

## CONGRATULATIONS!

You have now successfully connected the web database to Adobe Dreamweaver

**NOTE:** For a step-by-step tutorial for adding and manipulated dynamic web pages, please refer to the *Additional Web Development & Maintenance Guide Notes* at the end of this section.

## ADDITIONAL INFORMATION REQUIRED TO MANIPULATE DATABASE

---

In order to properly access the data entries from the MySQL data, a set of filters need to be set in order to ensure that the information users are editing is theirs. There are two different cases of filtering access to related database tables using Adobe Dreamweaver:

- Simple Filtering: For filtering one specific database table or linking one common data field used in two database tables.
- Advanced Filtering: For filtering and linking multiple data fields in multiple database tables.

### 1. Setting Simple Filters

- For this example, we will be creating a link between information stored in the `REGISTRATION` table and the `TEACHER` table through their `USERNAME` data field necessary for creating/editing a teacher's profile page.

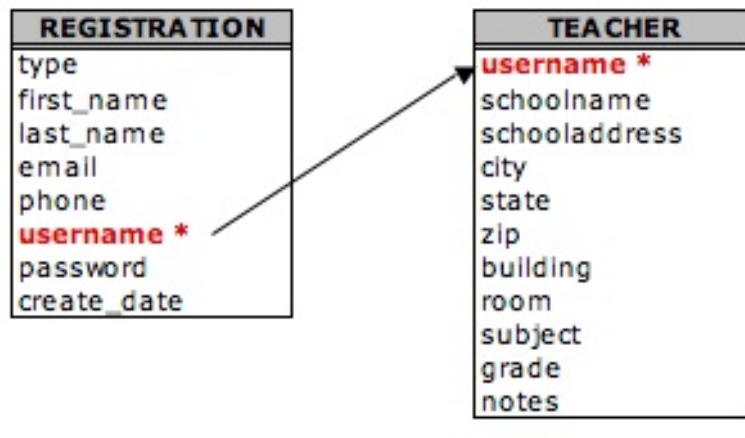
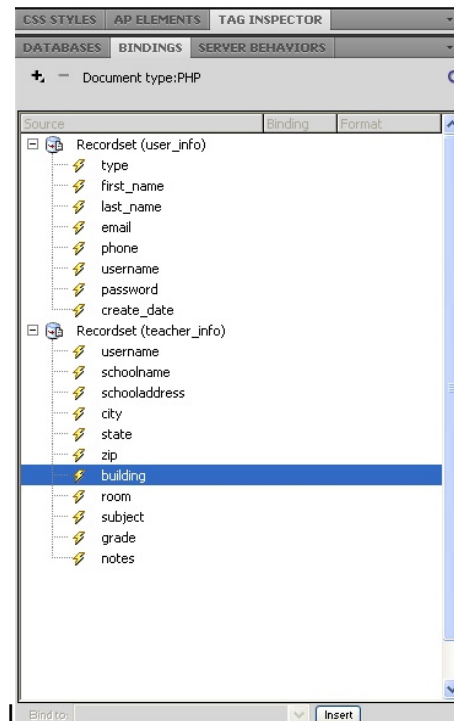


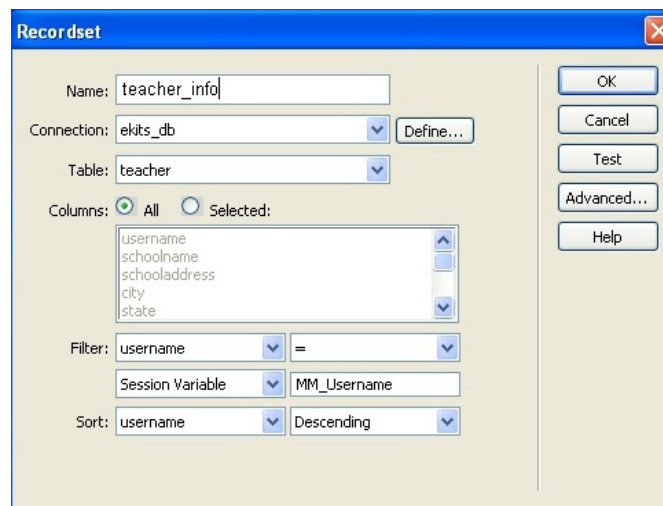
Figure B-14: Simple Filter example

- Figure B-15 displays the database definitions (Bindings) we want to access data from for this particular web page. In this case, Recordset(user\_info) represents data from the `REGISTRATION` table and Recordset(teacher\_info) represents data from the `TEACHER` table



**Figure B-15: Teacher Profile Bindings**

- Notice that each of these tables have a common data field called `USERNAME`. Using the Simple Filters option, we can link the two database tables together.
- Double click on Recordset(teacher\_info) and change the following information to match Figure B-16 below.



**Figure B-16: Setting a simple filter to link two database tables**

- For this example, set the USERNAME variable to the Session Variable >> MM\_Username, where MM\_Username is the username associated with the user that is currently logged on.
- Repeat the same filter for Recordset(user\_info).
- This filter now only allows the current user logged in to access his/her specific entry in the database.

## 2. Setting Advanced Filters

- Setting advanced filters is similar to setting a simple filter. However, additional SQL is necessary for creating multiple links between two or more data fields or database tables.
- For this example, we will be creating a link between information stored in the REGISTRATION table, RESERVATION table, and the TEACHER table necessary for displaying an e-kit reservation from a student profile's page.

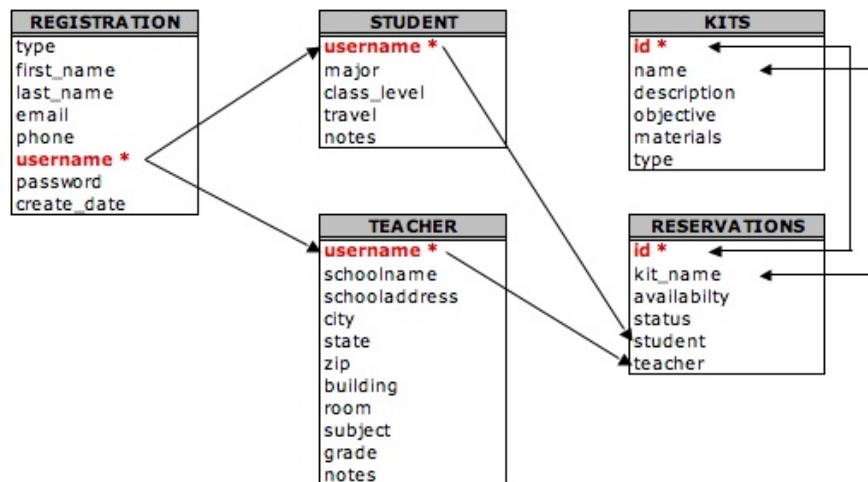


Figure B-17: Advanced Filter example

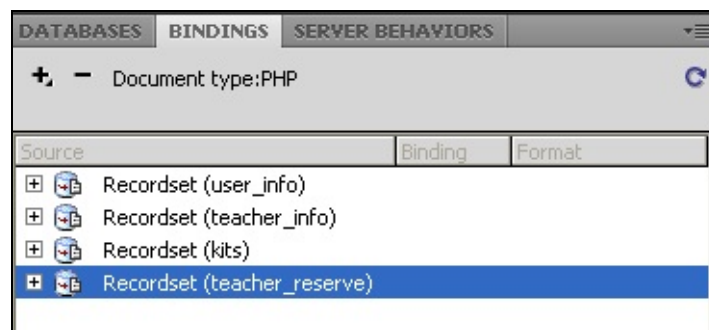
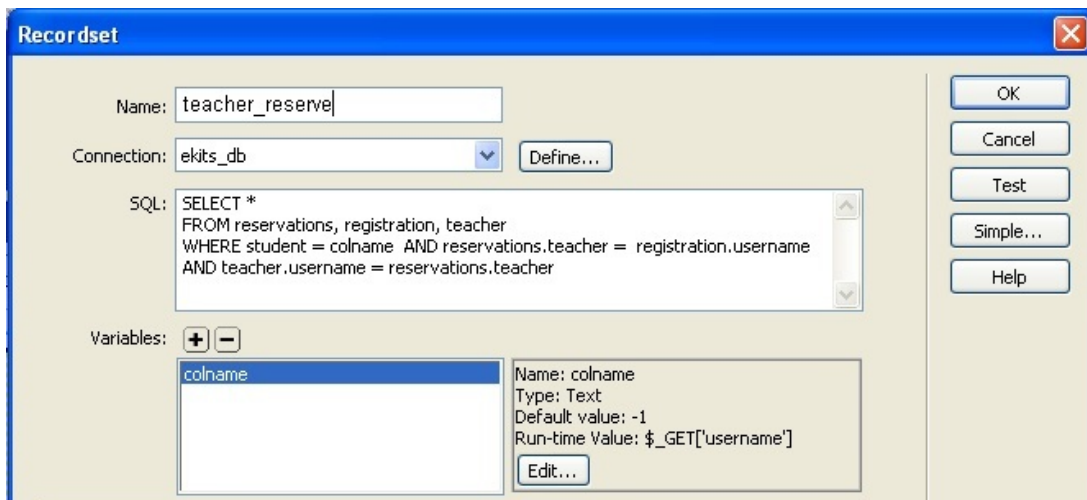


Figure B-18: Student Lesson Reservation Bindings

- In order for the student to view the correct teacher contact information associated with reserved lesson, multiple filters must be added to Recordset(teacher\_reserve) item found in the Bindings section.
- Double click on **Recordset(user\_info)**.
- Similarly to setting a Simple Filter, set the USERNAME variable to the Session Variable >> MM\_Username, where MM\_Username is the username associated with the student user that is currently logged on.
- Click **Advanced...** and change the code into the SQL box with the following (Figure B-19)

```
SELECT *
FROM reservations, registration, teacher
WHERE student = colname AND reservations.teacher =
registration.username AND teacher.username = reservations.teacher
```



**Figure B-19: Setting an advanced filter to link multiple database tables**

- The advanced SQL code allows the currently logged on student to access the complete contact info of the teacher who has reserved a particular lesson.

```
SELECT *
FROM reservations, registration, teacher
// tells us which database tables we want to get data from.

WHERE student = colname
//sets a link that allows the currently logged on student to access his/her student info.

AND reservations.teacher = registration.username
AND teacher.username = reservations.teacher
//sets a link allowing the student to view a teacher's registration and teacher profile via
the provided teacher username from the reservation.
```

## ADDITIONAL Web Development & Maintenance GUIDE NOTES

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This instructional guide was modeled after the following tutorial provided by:

<http://www.adobe.com>

For more information, refer to the “Creating a Dynamic Website” tutorial at:

[http://www.adobe.com/devnet/dreamweaver/articles/first\\_dynamic\\_site\\_pt1\\_06.html](http://www.adobe.com/devnet/dreamweaver/articles/first_dynamic_site_pt1_06.html)

## APPENDIX C: Accessing the E-Kit Website

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### E-KIT WEBSITE HOME PAGE

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1. Go to: <http://localhost/ekits/index.php>

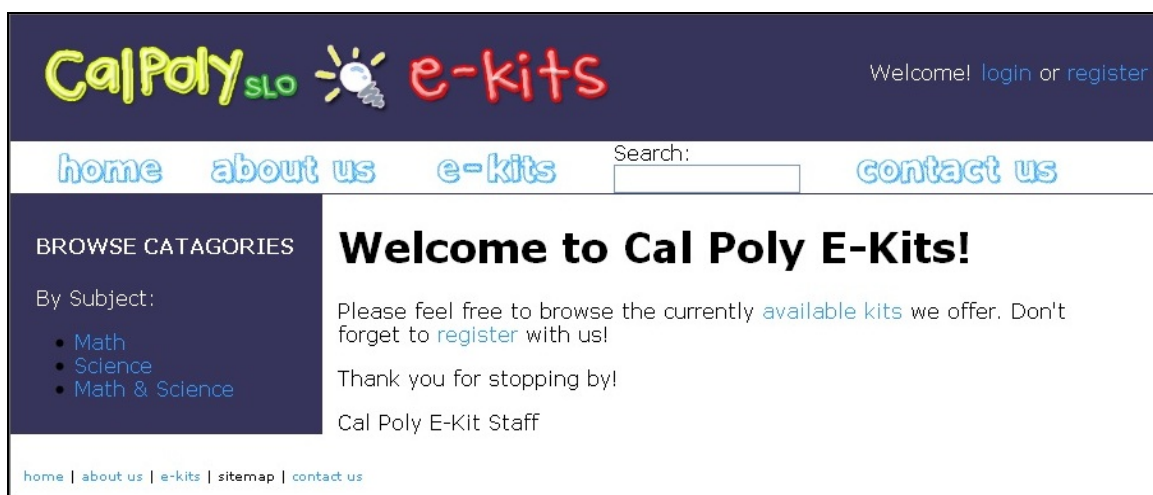


Figure C-1: E-Kit Homepage

### Registering an account

---

1. Click the **REGISTER** link
2. You will be redirected to the registration page.
3. Select the appropriate Type.
4. For Cal Poly student volunteers, choose **student**.
5. For teachers, choose **teacher**.
6. Complete remainder of the registration form with the appropriate information.

The screenshot shows the 'E-Kit Registration' page. The header is identical to the homepage. The main content area has a 'Hello! Ready to register with Cal Poly E-kits?' message. Below this is a form with fields for 'Type' (a dropdown menu set to 'student'), 'First name', 'Last name', 'Email', 'Phone', 'Username', and 'Password'. A 'Complete Registration' button is at the bottom of the form. The footer is also identical to the homepage.

Figure C-2: Registration Page

7. When finished, click **Complete Registration**.
8. You will be redirected to a confirmation page that will display the information you have just submitted.



## ACCESSING YOUR STUDENT/TEACHER PROFILE

---

1. Click the **LOGIN** link
2. Enter your **username** and **password**
3. Depending on the account type you selected during the registration process, you will be redirected to on of the following pages.

The figure consists of two screenshots of the CalPoly SLO e-kits website. The top screenshot shows the 'Student Profile' page. The header includes the CalPoly SLO e-kits logo, a greeting 'Hello, student student!', and links for 'logout' and 'view your student profile'. The navigation bar has links for 'home', 'about us', 'e-kits', and 'contact us', along with a search bar. A sidebar on the left titled 'BROWSE CATAGORIES' (sic) lists 'By Subject:' with links for 'Math', 'Science', and 'Math & Science'. The main content area is titled 'Student Profile' and contains form fields for 'Username' (pre-filled with 'student'), 'Major', 'Class level' (dropdown menu with 'freshman' selected), 'Preferred' (dropdown menu with 'none' selected), 'Travel Distance', and 'Additional Notes' (a large text area). A 'Create Profile' button is at the bottom. The footer shows links for 'home', 'about us', 'e-kits', 'sitemap', and 'contact us'. The bottom screenshot shows the 'Teacher Profile' page. It has a similar header and navigation bar. The sidebar is identical. The main content area is titled 'Teacher Profile' and contains form fields for 'Username' (pre-filled with 'ateacher'), 'School Information' (fields for 'SchoolName', 'Schooladdress', 'City', 'State', and 'Zip'), and 'Classroom Location' (fields for 'Building', 'Room', 'Subject', and 'Grade').

**Figure C-3: Create your student or teacher profile**

4. If you have already created your profiles, you will be redirected to your student or teacher profile page, where you have the ability to add, edit, and delete your contact, student/school, and kit reservation information.

## SETTING STUDENT VOLUNTEER AVAILABILITY

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1. When logged into your student profile, click **SEE AVAILABILITY**
2. You will be redirected to the Lesson Availability page, click **ADD AVAILABILITY**
3. Select the Kit name you would like to teach, and enter the data and time you are available to teach the lesson.

CalPoly SLO e-kits

Hello, student student! [logout](#)  
[view your student profile](#)

[home](#) [about us](#) [e-kits](#) Search:  [contact us](#)

**BROWSE CATAGORIES**

By Subject:

- [Math](#)
- [Science](#)
- [Math & Science](#)

**Teach a Lesson**

Kit name:

Date & Time availability:   
Ex: Monday, March 1, 2010 @ 8-10AM, 1030-12PM, or anytime

Student Username:

[home](#) | [about us](#) | [e-kits](#) | [sitemap](#) | [contact us](#)

Figure C-4: Setting teaching availability

## BROWSING E-KITS

---

1. Select the e-kits button on the menu bar. Use the left menu to browse kits by subject.

CalPoly SLO e-kits

Welcome! [login](#) or [register](#)

[home](#) [about us](#) [e-kits](#) Search:  [contact us](#)

**BROWSE CATAGORIES**

By Subject:

- [Math](#)
- [Science](#)
- [Math & Science](#)

**Electronic Kits**

**We currently offer the following Kits:**

1. **Name:** Simple Electromagnet  
**Type:** math & science [[view kit details](#)]
2. **Name:** Science Kit  
**Type:** science [[view kit details](#)]
3. **Name:** another  
**Type:** math [[view kit details](#)]

Figure C-5: Browse available E-Kits

## RESERVING A LESSON

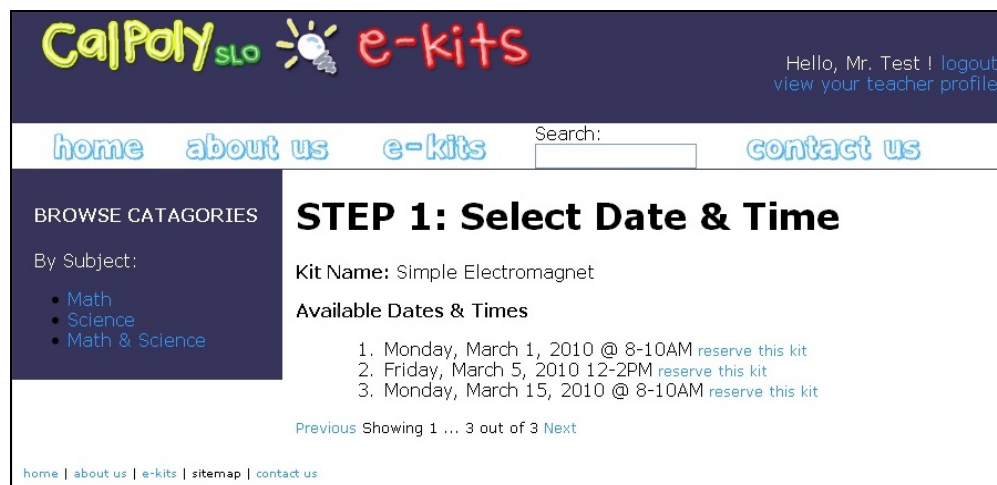
---

1. Browse E-Kits and Select **VIEW KIT DETAIL**, for the experiment you wish to reserve. Click **RESERVE THIS KIT** button



**Figure C-6: View Kit Detail**

2. A list of available dates and times will appear. Click **RESERVE THIS KIT**, next to the appointment that works best for you.



**Figure C-7: Kit Reservation**

3. Complete the kit reservation by following the information on the following pages.
4. After completing the reservation process, you will be redirected to a confirmation page with all the reservation information you have just selected.

1. Go to: <http://localhost/ekits/admin.php>

The screenshot shows the 'Administrator Login' page of the CalPoly SLO e-kits website. The header features the CalPoly SLO logo and 'e-kits' text, with a link to 'login or register as a member' for non-admins. The navigation bar includes 'home', 'about us', 'e-kits', a search box, and 'contact us'. On the left, a 'BROWSE CATAGORIES' sidebar lists 'Math', 'Science', and 'Math & Science'. The main content area is titled 'Administrator Login' and contains fields for 'Username' (pre-filled with 'admin') and 'Password' (masked with dots), followed by a 'Login' button. A footer at the bottom provides a site map with links to 'home', 'about us', 'e-kits', 'sitemap', and 'contact us'.

Figure C-8: Administrative Login Page

2. Enter **admin** in the username and password fields. (This default access can be changed or removed for future use)
3. Once access is granted, you will be redirected to the Database Manager page, where administrators have access for add/edit/delete information from the database.

The screenshot shows the 'Database Manager' page after a successful login. The header and navigation bar are identical to the login page. The 'BROWSE CATAGORIES' sidebar remains on the left. The main content area is titled 'Database Manager' and features a table with database information. In the top right corner, there is a 'logout admin' link. The footer is also identical to the previous page.

table name	description	action
admin	list of authorized administrators	<a href="#">view</a>
member accounts	list of registered members	<a href="#">view</a>
ekits	electronic kit manager	<a href="#">view</a>
reservations	list of confirmed reservations	<a href="#">view</a>

Figure C-9: Database Manager

## APPENDIX D: Simple Electromagnet Power Point Presentation

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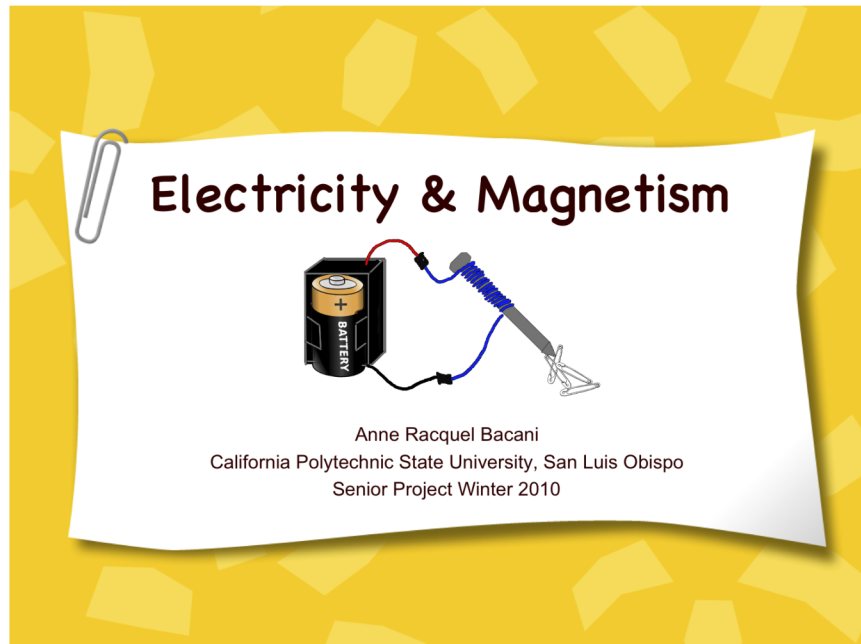


Figure D-1

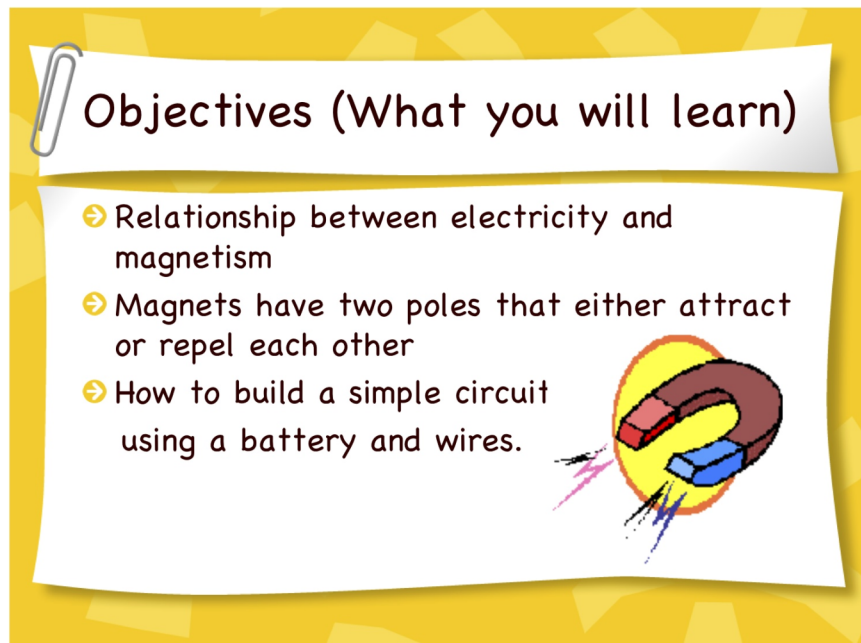


Figure D-2

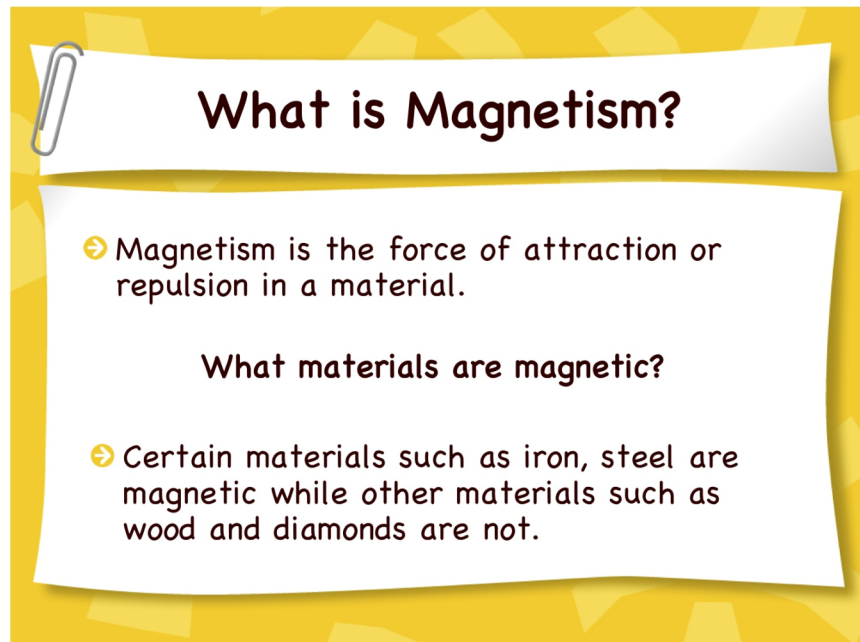


Figure D-3

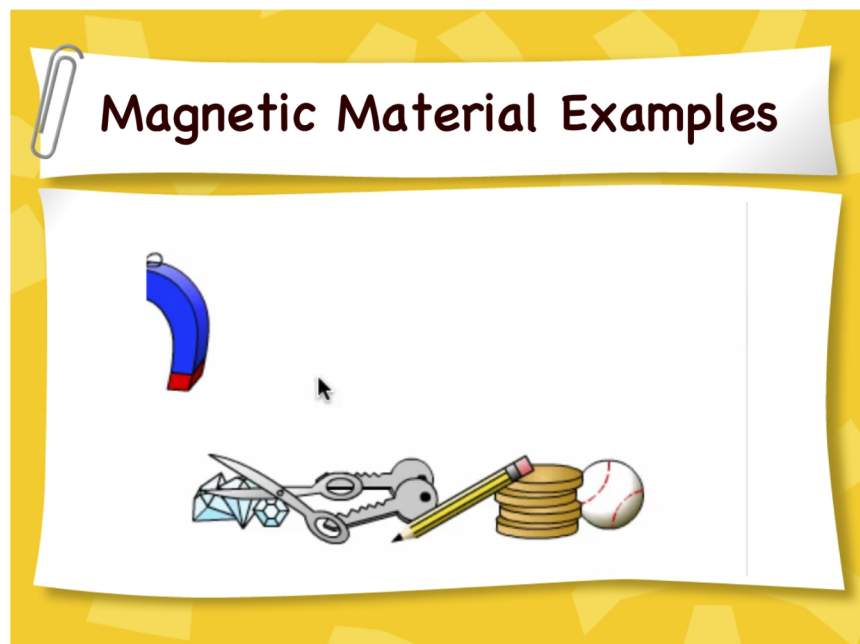


Figure D-4

## What is Polarity?

- ➔ Every magnet has 2 poles (ends): a North (N) pole and a South (S) pole.

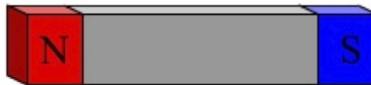


Figure D-5

## Properties of Magnetic Poles

- ➔ What will happen when you bring two opposite poles of a magnet near each other?



Figure D-6



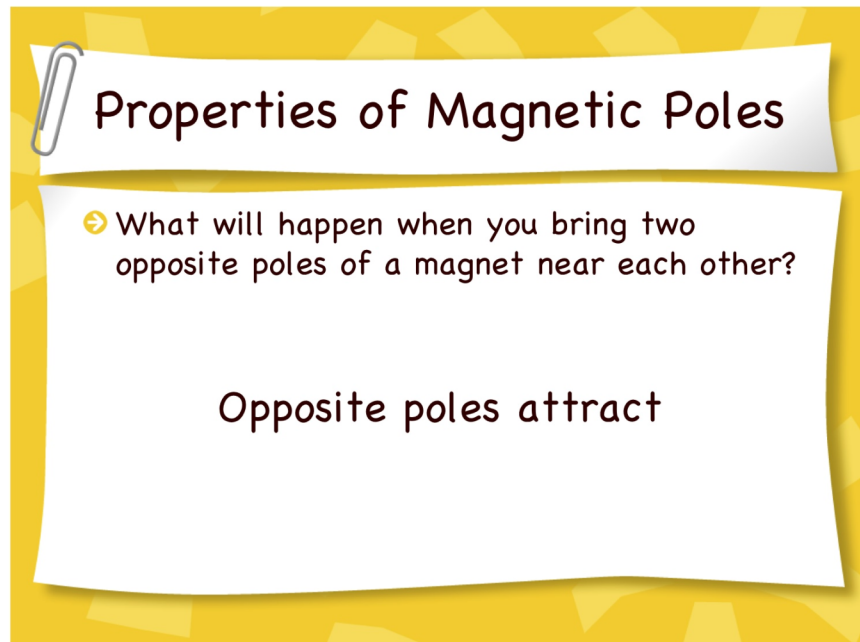


Figure D-7

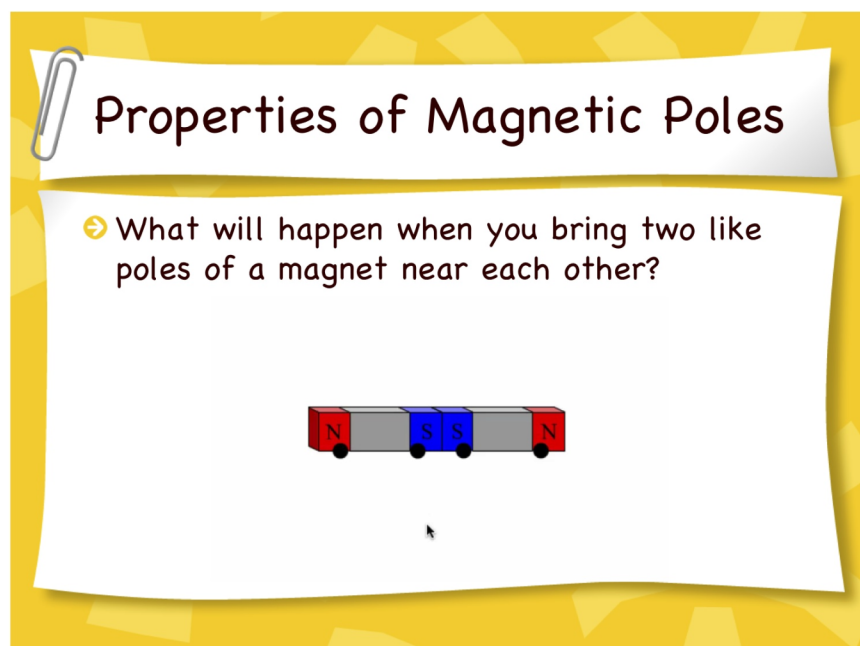


Figure D-8



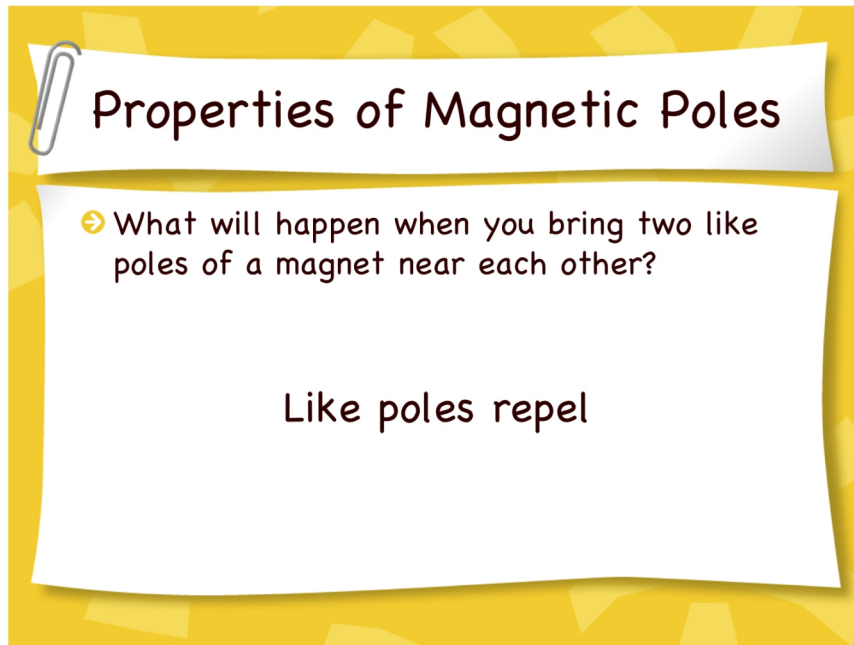


Figure D-9

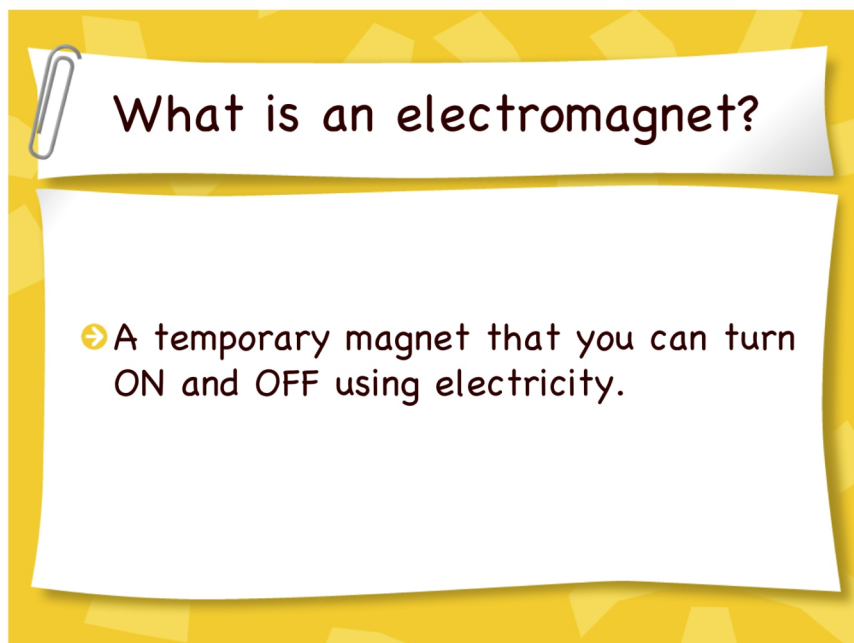


Figure D-10

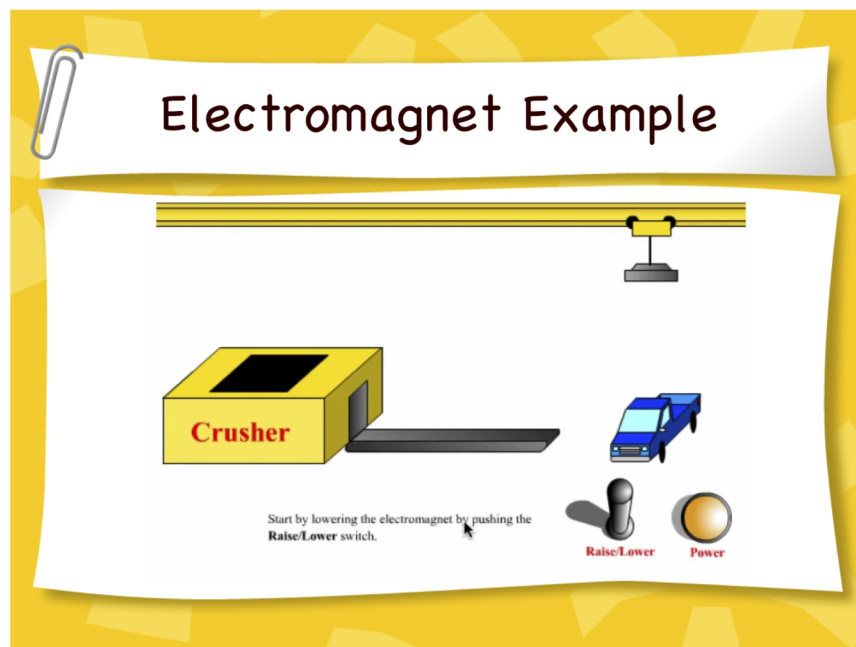


Figure D-11

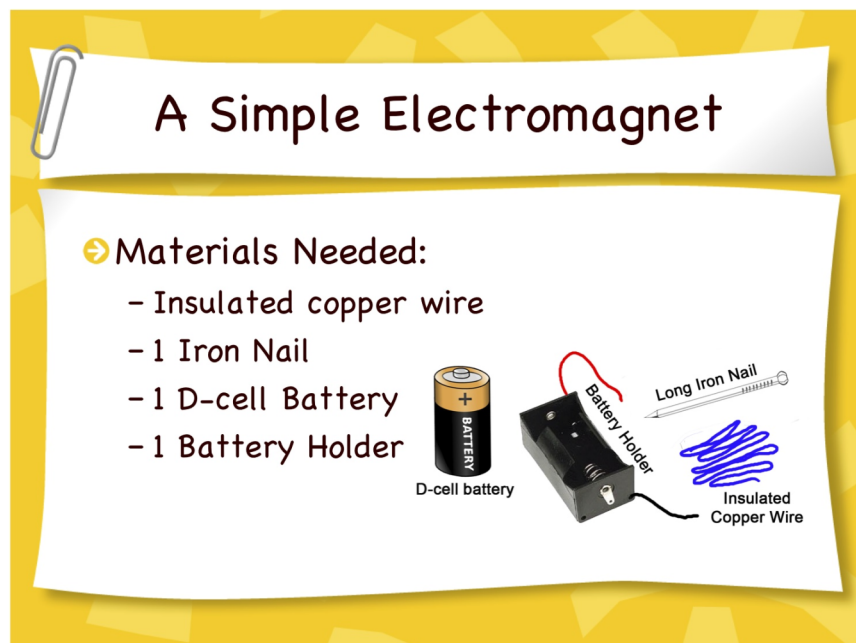
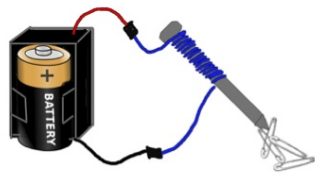


Figure D-12

## APPENDIX E: Simple Electromagnet Workbook

### Electromagnetic Nail Experiment

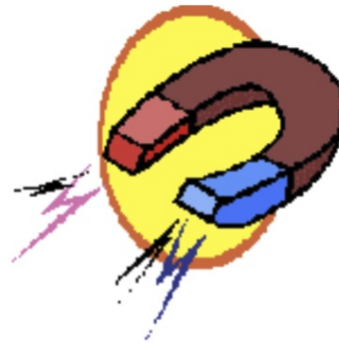


Name: \_\_\_\_\_

#### Objectives:

Students will observe, learn and understand:

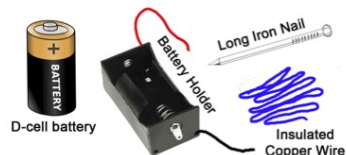
- The relationship between electricity and magnetism.
- How an electrically charged object attracts or repels each other.
- Magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.



2

#### Materials Needed:

- Insulated copper wire
- 1 long iron nail
- D cell battery
- Battery Holder



#### Testing Materials:

- Paper Clips
- Compass
- Safety pins



3

#### PART 1

#### Procedure:

1. Place 1 D cell battery into the battery holder.
2. Straighten out approximately 2 inches off one end of the copper wire.
3. Wrap the copper wire around the iron nail 10 times beginning from its head to point in the same direction and avoid spaces between turns.
4. Attach the alligator clips to the exposed ends of the wire. Never touch the alligator clips together, you run the risk of losing the battery's charge



4

Figure E-1: Pages 1-4 of Electromagnet Workbook

5. **Prediction:** What do you think will happen if you move the nail near the safety pins?

---

---

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6. **Move the point of nail near the safety pins.**  
**Write down your observation:**

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5

7. **Prediction:** If you unhook the battery while the safety pins are still attached to the nail, what happens? What happened to the nail?

---

---

---

---

---

---

---

8. **What did you observe? Why?**

---

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---

**End of PART 1**

6

## PART 2

9. **Using the electromagnet, record how many safety pins and paper clips you picked up in the Table 1.**

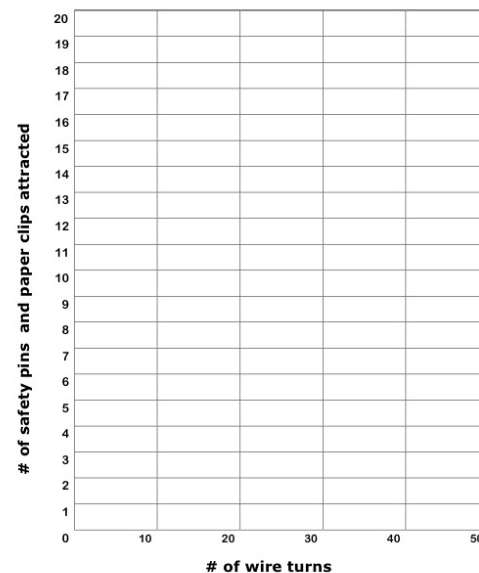
\*\*\* To avoid over heating, be sure to disconnect the top connection from nail and the red wire of the battery holder between each wire wrap test. \*\*\*

# of coils wrapped around the nail	# of safety pins picked up	# of paper clips picked up
10		
20		
30		
40		
50		

**Table 1**

7

10. **Graph your data from Table 1 below.**



8

**Figure E-2: Pages 5-8 of Electromagnet Workbook**

11. Is there a relationship between the number of wire wrappings and the number of safety pins you can pick up? What is this relationship?

---

---

---

---

---

12. For the same number of wraps, do you think you will be able to pick up more or less paperclips than safety pins? Why?

---

---

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---

---

9

13. By moving the point of your electromagnet near the compass, you can test the polarity of your magnet. Which end of the compass does it attract?



14. Prediction: What will happen if you switch the wire connections to the battery?

---

---

---

15. Switch the connections to the battery to test your prediction. Hypothesis: Why do you think this happened?

---

---

---

---

10

16. Using the electromagnet, test if some items in your desk to see if they can be attracted magnetically. Record your findings below:

Attracted to the magnet	Not attracted to the magnet

11

17. Why are some items attracted to the magnet and some are not?

---

---

---

---

---

12

Figure E-3: Pages 9-12 of Electromagnet Workbook

## APPENDIX F: Administrative Checklist & Sample Lesson Script

The following checklist and lesson script was used to administer the Simple Electromagnet lesson on January 28<sup>th</sup>, 2010 to Ms. Franco's fourth and fifth grade combination class.

**Lesson #1: Simple Electromagnet**  
Ms. Franco's 4th/5th grade class  
Ocean View Elementary School  
January 28<sup>th</sup>, 2010

  
**PRE-LESSON NOTES & CHECKLIST**

- Make sure each kit has the following materials:
  - ☐ Copper wire (3 feet)
  - ☐ 1 iron nail
  - ☐ 1 D-cell battery
  - ☐ 1 D-cell battery holder
  - ☐ 1 compass
  - ☐ paper clips and safety pins (at least 20 each)
- Make copies of workbooks for each student.  
See teacher request for number of students in the classroom
- Double check time & location of lesson  
Arrive at least 15 minutes prior for set-up.
- Review the following lesson plan procedure

**LESSON PLAN PROCEDURE**

- Introduction:  
Hi, my name is \_\_\_\_\_. I am a *(insert major here)* at Cal Poly. Today I will be teaching you all how to create a simple electromagnet using an iron nail, battery, and copper wire.
- Intro/Review of Magnetism & Polarity power point presentation.
- Short Explanation of Procedure
  - Draw out "schematic" of experiment & explain the following as you draw:

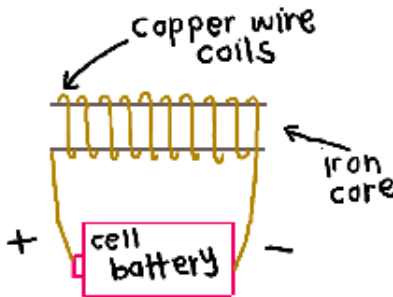


Figure F-1: Sample Administrative Checklist and Lesson Plan

- Taking an iron nail, wrapping around the copper wire around the nail, starting at one end.
  - Wrap always the same way around backwards and forwards until you have a good amount of turns on the nail.
  - Attaching the free ends of the wire to the ends of a cell battery.
  - You created a closed circuit that allows current to flow through the wire and charge up the nail. Thus creating a simple electromagnet.
  - Electromagnet is NOT permanent; its only works as long as there is current flowing through it.
  - Switch ON – attach both ends to batteries
  - Switch OFF – detach one end
  - After awhile the nail will retain its magnetism.
    - Uncoil & recoil the opposite way to demagnetize it.
  - And that is how you create a simple electromagnet!
- Video or Live Demo showing a final working electromagnet
- Lesson administration approach: Depends on teacher/class preference/ability
  - Step-by-Step follow the teacher instruction
  - Self-Instructions via workbook manual.

**OTHER NOTES:**

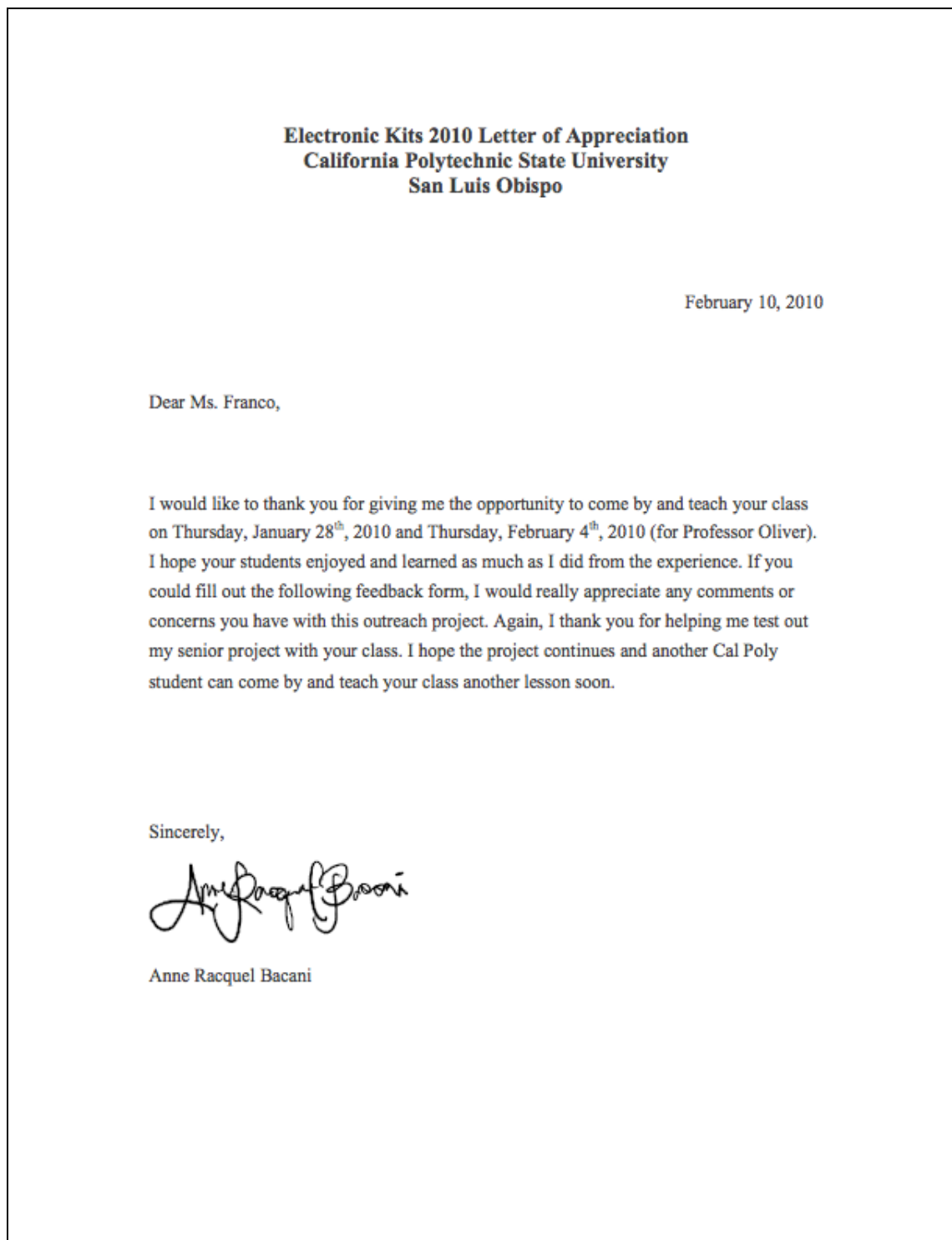
- Advantages of electromagnets: (Things they will discover)
  - Ability to control its magnetic strength by:
    - Increasing cells (voltage), which increase current
    - Increase # of coils
- **WARNING:** Remind students of hazards
  - Do NOT clip ends of alligator clips together. This will short your battery
  - Do NOT keep connection closed too long, it will overheat your battery and eventually short it.

**Figure F-2: Sample Administrative Checklist and Lesson Plan (cont.)**

## APPENDIX G: Post Lesson Thank You Letter & Feedback Form

---

The following is a sample thank you letter sent to the teacher of the class I taught.



**Figure G-1: Sample Thank You Letter**



The following is an example feedback request form sent to the teacher of the classroom I taught at. A similar form can be generated for the student volunteer who taught the lesson.

**Electronic Kits 2010 Feedback Form**  
**California Polytechnic State University**  
**San Luis Obispo**

Teacher's Name: Colleen Franco \_\_\_\_\_ Student Administer: Anne Racquel Bacani  
School: Ocean View Elementary School \_\_\_\_\_ Grade Level: 4<sup>th</sup>/5<sup>th</sup> combo  
Experiment: Electromagnets \_\_\_\_\_ Dates Administered: 01/28/10 & 02/04/10

1. How affective was the lesson in achieving your science and math objectives?

2. What were the strengths and aspects that you liked most about the lesson?

3. What aspects would you like to see improvement on? Please list suggestions for changes (if any)

4. Additional comments:

**Figure G-2: Sample Feedback Request Form**

## APPENDIX H: Bill of Materials

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List of Final Supplies used in the Simple Electromagnet E-Kit:

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### Experiment Materials

- Iron nails
- Insulated copper wire
- D cell battery holders
- Alligator clips
- D cell batteries

### Testing Materials

- Paper Clips
- Safety Pins
- Compass

### Kit Storage

- Ziploc container
- Battery container (Ziploc bags)

*Original estimated cost: \$100* (Includes experimental testing materials)

BILL OF MATERIALS (includes develop & Testing materials)

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**Table H-1: Final Bill of Materials**

ITEM	PRICE	QUANTITY PER KIT
<b>Experiment Materials</b>		
Iron nails	\$3.77	1
Insulated copper wire	\$5.00	3 feet
D cell battery holders	$0.99 \times 10 = \$10$	1
Alligator Clips	\$5.58	2
D cell batteries	\$12.00	1
<b>Testing Materials</b>		
Paper Clips	$0.99 \times 6 \text{ Boxes} = \$7$	20
Safety Pins	$1.25 \times 3 \text{ Boxes} = \$3.75$	20
Compass	\$13.98	1
<b>Kit Storage</b>		
Ziploc container	\$5.48	1
Ziploc bags	\$1	1
<b>Additional Development/Testing Materials (not used in final project)</b>		
Magnet wire	\$20.16	
Emery boards	\$1.99	
Galvanized iron nails	\$4.61	
Staples	\$2.49	
<b>Total spent</b>	<b>\$ 96.81</b>	

## APPENDIX I: Gantt Chart

The following Gantt chart reflects the estimated timeline for project development and testing at the beginning of Senior Project I.

Estimated Timeline:

1. FALL 2009: E-Kit development & classroom visit preparation
2. WINTER 2010: Classroom visits & database website development

Senior Project Gantt Chart: E-Kit

FALL 2009						T H A N K S G I V I N G	F A L L						
Week 5		Week 6		Week 7				Week 8		Week 9			
10/19 - 10/23		10/26 - 10/30		11/02 - 11/06				11/09 - 11/13		11/16 - 11/20			
TASK/ASSIGNMENT								11/30 - 12/04		11/30 - 12/04			
E-Kit Development								Prototype final development & testing		Prototype final development & testing			
* Nail Magnet		building, testing and playing											
* Lemon Battery													
* Potato Clock													
* Electric Motor				building, testing & playing									
* Basic Circuit Design								building, testing & playing					
Worksheets						Finalize Lesson Plans & Workbooks		Maybe?					
* Experiment Procedure		nail magnet experiment for 4th		expand nail magnet experiment for 5th & 6th						electric moter experiment for 4th		electric motor experiment for 5th & 6th grade	
* Questions & Answers													
Classroom Presentations													

WINTER BREAK						WINTER 2010			
Week 1		Week 2		Week 3		Week 1		Week 2	
12/14 - 12/18		12/21 - 12/25		12/28 - 01/01		01/04 - 01/08		01/11 - 01/15	
TASK/ASSIGNMENT									
Website Development									
* Web Environment		Set up host environment							
* Database				learn basic database input				profile input layout	
* Design website				build basic design layout		design meeting availability/profile view			
* Testing						throughout implementation			
Classroom Presentations						begin by the end of January			

WINTER 2010									
Week 3		Week 4		Week 5		Week 6		Week 7	
01/18 - 01/22		01/25 - 01/29		02/01 - 02/05		02/08 - 02/12		02/15 - 02/19	
TASK/ASSIGNMENT									
Website Development									
* Set up database		student profile sheet		teacher profile sheet				input e-kit options	
* Design website						clean up layout			
* Testing		test profile input						test availability & kit matching	
Classroom Presentations						Class presentation?			

WINTER 2010					
Week 8		Week 9		Week 10	
02/22 - 02/26		03/01 - 03/05		03/08 - 03/12	
TASK/ASSIGNMENT					
Website Development					
* Set up database		fix bugs & make sure everything works			
* Design website		finalize and clean up design			
* Testing				Usability Feedback & Testing	
Classroom Presentations				Class presentation?	

\* Note: Documentation will be done through out FALL & WINTER Quarters

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Figure I-1: Estimated Project Timeline

## APPENDIX J: Bibliography & References

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